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Hymenoptera
Chapter 12

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Abstract

We present the first review of Hymenoptera alien *to* Europe. Our study revealed that nearly 300 species of Hymenoptera belonging to 30 families have been introduced to Europe. In terms of alien species diversity within invertebrate orders, this result ranks Hymenoptera third following Coleoptera and Hemiptera. Two third of alien Hymenoptera are parasitoids or hyperparasitoids that were mostly introduced for biological control purposes. Only 35 phytophagous species, 47 predator species and 3 species of pollinators have been introduced. Six families of wasps (Aphelinidae, Encyrtidae, Eulophidae, Braconidae, Torymidae, Pteromalidae) represent together with ants (Formicidae) about 80% of the alien Hymenoptera introduced to Europe. The three most diverse families are Aphelinidae (60 species representing 32% of the Aphelinid European fauna), Encyrtidae (55) and Formicidae (42) while the Chalcidoidea together represents 2/3 of the total Hymenoptera species introduced to Europe. The first two families are associated with mealybugs, a group that also included numerous aliens to Europe. In addition, they are numerous cases of Hymenoptera introduced from one part of Europe to another, especially from continental Europe to British Islands. These introductions mostly concerned phytophagous or gall-maker species (76 %), less frequently parasitoids. The number of new records of alien Hymenoptera per year has shown an exponential increase during the last 200 years. The number of alien species introduced by year reached a maximum of 5 species per year between 1975 and 2000. North America provided the greatest part of the hymenopteran species

alien *to* Europe (96 species, 35.3%), followed by Asia (84 species, 30.9%) and Africa (49 species, 18%). Three Mediterranean countries (only continental parts) hosted the largest number of alien Hymenoptera: Italy (144 spp.), France (111 spp.) and Spain (90 spp.) but no correlation was found with the area of countries. Intentional introduction, mostly for biological control, has been the main pathway of introduction for Hymenoptera. Consequently, the most invaded habitats are agricultural and horticultural as well as greenhouses. To the contrary, Hymenoptera alien *in* Europe are mostly associated with woodland and forest habitats. Ecological and economic impacts of alien Hymenoptera have been poorly studied. Ants have probably displaced native species and this is also true for introduced parasitoids that are suspected to displace native parasitoids by competition, but reliable examples are still scarce. The cost of these impacts has never been estimated.

Keywords
Hymenoptera, alien, Europe, biological invasions

12.1. Introduction

Hymenoptera is one of the four large insect orders exceeding 100 000 species in the world, the other major orders being Coleoptera, Lepidoptera and Diptera (Gauld and Bolton 1988, Goulet and Huber 1993). The Hymenoptera order contains about 115 000 described species and authors estimated that there are between 300,000 and 3,000,000 species of Hymenoptera (Gaston 1991), possibly around 1,000,000 (Sharkey 2007). These estimates mean that only 1/10 has been described so far and 9/10 awaits description. However, the number of Hymenoptera species is difficult to estimate with accuracy, as most of the mega diverse regions of the world have not been extensively studied and inventoried regarding this group (LaSalle and Gauld 1993). In Europe, about 15,000 species have been reported belonging to 73 families, but undoubtedly thousands of species remains to be discovered and described. From our recent review of the literature, the alien species of Hymenoptera comprise 286 species belonging to 30 families. The order ranks third just following the Coleoptera and the Hemiptera in terms of alien species diversity (Roques et al. 2008). Additionally, 71 European species have been translocated from one part of Europe to another (adding 5 more families) and 11 species are considered cryptogenetic. All together within Europe, at least 368 Hymenoptera species have been introduced in different parts of the continent.

Hymenoptera have been traditionally subdivided into three assemblages (the paraphyletic sub-order Symphyta and the monophyletic Aculeata and Parasitica belonging to the sub-order Apocrita). Each group exhibits different biology. 'Symphyta' are mostly phytophagous and are the most primitive members of the order. Parasitica are mainly parasitic species but some of them have returned secondarily to phytophagy, while Aculeata encompass a larger spectrum (predators, pollinators, parasitoids); all eusocial hymenoptera belong to this last group.

Members of the Hymenoptera are familiar to a general audience and common names exist for a large variety of groups: "wasps", "bees", "ants", "bumblebees", "saw-

flies", "parasitic wasps". Hymenoptera adult sizes range from the very small Mymaridae (0.5 mm) to the large aculeate wasps (up to 5 cm long in Europe). This group of mandibulate insects is well defined by the combination of several characters: they have two pairs of functional wings (with the exception of apterous species) bearing fewer veins than most other insect groups and rarely more than seven cross veins. The abdominal tergum 1 is fused to the metanotum and in most Hymenoptera the metasoma (apparent gaster) is joined to the mesosoma (apparent thorax) by a petiole.

Hymenoptera have two main larval types. 'Symphyta' have larvae that are caterpillar-like, but true caterpillars (Lepidoptera) have at most four pairs of prolegs (abdominal segments 3–6) while sawflies larvae have at least five pairs of prolegs (abdominal segments 2–6). Furthermore the prolegs of Symphyta do not bear crochets, whereas those of Lepidoptera larvae do. 'Apocrita' have legless grub-like larvae that are nearly featureless unless they have a differentiated head (Goulet and Huber 1993). All Hymenoptera have haplodiploid sex determination (haploid males and diploid females). Arrhenotoky is the most common mode of reproduction in Hymenoptera (Heimpel and de Boer 2008). The males develop parthenogenetically from unfertilised eggs while the females develop from fertilised eggs. Females can control fertilisation by releasing sperm to an egg upon oviposition, and can thus adjust the sex-ratio of their progeny.

Ecologically and economically few groups of insects are as important to mankind as the Hymenoptera. Bees provide the vital ecosystem service of pollination in both natural and managed systems (Gallai et al. 2009) while parasitic Hymenoptera control populations of phytophagous insects (Tscharntke et al. 2007) and can be effective agents for control of pest insects (Bale et al. 2008, Brodeur and Boivin 2004, Jonsson et al. 2008). Some of the phytophagous hymenoptera have an intimate association with their host-plants (Nyman et al. 2006) and can also be considered as major pests to forests (e.g. Diprionidae) (De Somviele et al. 2004, Lyytikainen-Saarenmaa and Tomppo 2002). Ant invasions cause huge economic and ecological costs (Holway 2002, Lach and Thomas2008) and Hymenoptera stings, specifically those of wasps, hornets and bees cause serious allergic reactions and anaphylaxis (Flabbee et al. 2008, Klotz et al. 2009).

12.2. Taxonomy of alien species

The 286 species of Hymenoptera alien *to* Europe belong to 30 different families (Table 12.1), which also have native representatives. Among these alien species, 35 species are phytophagous, 1 detritivorous, 3 pollinators, 47 predators whilst 200 are parasitoids or hyperparasitoids. These results show that only 13.3% of the alien wasp and bee species are phytophagous (including pollinators), the great majority of which (86.4 %) are predators and parasitoids (respectively 16.4% and 70.0%). Most parasitoids were intentionally introduced to control pests. Interestingly, among the 71 Hymenoptera that have been introduced from one part of Europe to another (aliens *in* Europe - Table 12.2), an opposite proportion is observed. Fifty-four species (76.0 %) are phytopha-

gous and only 17 (23.9%) are parasitic or predatory. These species have mostly followed their host plants throughout Europe.

Consequently, most alien Hymenoptera in Europe belong to the sub-order Parasitica (228 spp. and 20 families, 79.4% of the species), while Aculeata (51 spp. and 7 families, 17.8%) and Symphyta (8 spp. and 3 families, 2.8%) are less represented. Six families of wasps (Aphelinidae, Encyrtidae, Eulophidae, Braconidae, Torymidae, Pteromalidae) represent together with ants (Formicidae) about 80% of the alien Hymenoptera in Europe. Each of these families has more than 10 introduced species in Europe. The three most diverse families in terms of alien species are Aphelinidae (60 species), Encyrtidae (55) and Formicidae (42). By far the richest superfamily is the Chalcidoidea that includes 198 alien species (69.2% of the total alien Hymenoptera). Below we give a short synopsis for all Hymenoptera families containing introduced species to Europe (including cryptogenic and translocated species).

Suborder Symphyta

Argidae. The second largest family of 'Symphyta' with about 1000 species described, but only 60 in Europe. Alien species *to* Europe have not yet been found. One species only, *Arge berberidis,* is considered as introduced from one part of Europe to another,. Females deposit eggs in leafs of various angiosperms and the larvae are phytophagous, feeding mostly on woody plants (Salicaceae, Rosaceae, Betulaceae).

Blasticotomidae. This is a very small family represented by one species only, *Blasticotoma filiceti*, in northern and central Europe. Larvae are stem borers, developing within the rachis of ferns (e.g., *Athyrium filix-femina* (L.) Roth) (Schedl 1974). *B. filiceti* has been infrequently introduced into Great Britain from continental Europe, mostly with horticultural plants.

Diprionidae. A small family of 'Symphyta' that mostly occurs in northern Europe. It comprises about 100 species in the northern hemisphere, of which 20 occur in Europe. The larvae attack softwood trees (e.g. conifers) and are considered as major pests in forestry. Diprioninae develop on Pinaceae and Monocteninae on Cupressaceae, but only the first subfamily contains invaders. Alien species have not yet been recorded. However, five species are considered as alien *in* Europe. *Neodiprion sertifer* and *Gilpinia hercyniae* cause severe damage to pine and spruce plantations. Females of some species produce pheromones that attract males. The larvae consume needles, sometimes gregariously, and when mature drop to the ground, pupate and overwinter within a cocoon (rarely upon trees). Diapause can last for more than one winter (Pschorn Walcher 1991), the wasps emerging and dispersing in the early spring.

Pamphiliidae. A small holarctic family containing about 60 species in Europe (van Achterberg and van Aartsen 1986, Viitasaari 2002). Only *Cephalcia alashanica* is an alien species introduced from temperate Asia. Six other species are alien in Europe, most of them having been introduced from the Alps to northern countries with their host trees. Some species attack conifers and are considered as forest pests. Females lay eggs

in a slit cut in a needle, the normally gregarious larvae either spin silk webs in which they develop (Cephalciinae) or roll the host plant leaves (Pamphiliinae). They overwinter as pupae within pupal chambers in the soil and adults emerge in early spring.

Siricidae. A small Holarctic family (16 European species) of large and conspicuous wasps (woodwasps). Nine species are considered as alien in Europe, with only 5 alien species introduced from North America with imported timbers. The family is subdivided into two subfamilies, the Siricinae attacking conifers and the Tremecinae that attack angiosperm trees. The females, which do not feed, oviposit in recently fallen or dying trees and introduce spores of symbiotic fungus along with the eggs. The larvae develop in 2 or 4 years as woodborers and pupate in the bark.

Tenthredinidae. This cosmopolitan family is the most diverse group of 'Symphyta' including 1050 species in Europe of which only two are alien *to* Europe , *Nematus* (*Pteronidea*) *tibialis* (a pest of black locust) and *Pachynematus* (*Larinematus*) *itoi* (a larch pest) and 23 alien *in* Europe. Some native European species are also considered serious pests in North America where they have been introduced. All species are phytophagous and the larvae are mostly external feeders on diverse species of angiosperms and conifers. The females embed their eggs in the tissue of the plant, using their ovipositor as a saw. The larvae feed singly on leaves, or are stem borers, gall makers or leaf miners. Tenthredinidae mostly overwinter as prepupae in the ground, sometimes as mature larvae or eggs, the adults emerge relatively early in the spring.

Suborder Apocrita Parasitica

Chalcidoidea

Agaonidae. A small-sized family with only 6 species of wasps reported in Europe, four of which are introduced from tropical Asia, along with two ornamental trees *Ficus microcarpa* L.f. and *F. religiosa* L. Agaonidae are the pollinators of fig trees and are mutualistically associated with their host plant. Several groups of non-pollinating fig wasps are associated with figs, either as gall-makers, inquilines or parasitoids. Their taxonomic position has been discussed and they are here grouped within Agaonidae for convenience (Bouček 1988, Rasplus et al. 1998).

Aphelinidae. This is a moderately sized family of wasps represented in Europe by less than 200 species of which sixty are aliens. Aphelinidae species have been introduced from diverse geographic areas as biological control agents. Along with encyrtid, the Aphelinidae is the most important family for biological control. Species are primarily endoparasitoids or ectoparasitoids, sometimes hyperparasitoids, of sternorrhynchous Hemiptera (mostly Aphidoidea, Coccoidea or Aleyrodoidea). Some species may have complicated ontogeny (Hunter and Woolley 2001) and males and females may attack different hosts either as parasitoids or hyperparasitoids.

Chalcididae. A small family of chalcid wasps comprising about 80 species in Europe, including one alien species, introduced from North Africa to control fruit flies.

The hosts of these obligate parasitoids or hyperparasitoids are mostly Lepidoptera and Diptera, less frequently Coleoptera, Neuroptera or Hymenoptera (Delvare 1995, Delvare 2006). The females lay eggs within the host larva and the pupation take place in the host pupa.

Encyrtidae. A large family of wasps represented by more than 700 species in Europe (Trjapitzin 1989), of which 55 are considered to be alien, introduced from different parts of the world for biological control of economically important pests (Noyes and Hayat 1994). Most of the Encyrtidae are endoparasitoids of scale insects. Some species also develop as endoparasitoids of other insect orders, mostly Lepidoptera, Coleoptera and Hymenoptera). The egg is laid inside the host and the larva develop as a parasitoid sometimes as an hyperparasitoid, and pupates within the host.

Eulophidae. A large family of wasps that contains 1100 species in Europe (Gauld and Bolton 1988), including 29 alien species. Most alien species have been introduced for biological control but a few (3) are gall makers that develop at the expense of plant tissue of *Eucalyptus* (Branco et al. 2009). Eulophid are primarily solitary parasitoids of eggs, pupae or larvae of various endophagous insects (Diptera, Coleoptera, Thysanoptera, Lepidoptera or Hymenoptera). Some species attack economically important leaf miners or gall makers (e.g. Agromyzidae, Cecidomyiidae).

Eupelmidae. A small family represented by about 100 native (Gibson 1995) and 5 alien species in Europe (*Eupelmus* and *Anastatus* spp.). Eupelmidae are primarily ectoparasitoids (idiobionts) of egg or larval stages of various insects and spiders (Askew et al. 2000). Some species within this family are generalist parasitoids.

Eurytomidae. A medium-sized family with about 300 species in Europe (Zerova 1978), of which seven are alien. Interestingly, these alien species are not parasitoids but phytophagous and pests of crops or horticultural plants whilst most eurytomids are primarily ectoparasitoids or hyperparasitoids of extremely diverse groups of endophagous insects (Lotfalizadeh et al. 2007). Phytophagous species are either stem-borers or seed-feeders or gall-makers on different host-plant groups (e.g. Graminaceae, Leguminosae). Some species are both entomophagous then phytophagous during their larval development.

Mymaridae. A medium-sized family including about 450 species in Europe, of which only two are alien, *Anaphes nitens* and *Polynema striaticorne*. All mymarids are internal, solitary (rarely gregarious) parasitoids of the eggs of various insects (Huber 1986). The most common hosts are eggs of Hemiptera Auchenorrhyncha (Cicallidae, Cixiidae) but mymarids also parasitize eggs of other insects (Coleoptera, Hemiptera). Female oviposit within concealed eggs, and there are 2 to 4 larval stages.

Perilampidae. A small family of chalcid wasps that includes 40 European species. The only alien species in this family (*Steffanolampus*) originates from North America and is a parasitoid of wood-boring Coleoptera. Most perilampids are hyperparasitoids of Lepidoptera through Tachinidae (Diptera) or Ichneumonoidea (Steffan 1952). Females deposit their eggs away from the host, however the young larvae (planidium) are mobile, and may either attach themselves to the primary host, at any stage of larval development, or enter the host to attach to its endopara-

sitoids. In some species, an adult host carries the larva to a suitable location where host larvae occur (Darling 1999).

Pteromalidae. A large, paraphyletic family including more than 1100 species in Europe (Graham 1969). Only ten are considered alien species, most of which were unintentionally introduced with their hosts, some (3) for biological control purposes. The diversity of the group is reflected by the diversity of the biology exhibited. Pteromalids are mostly ectoparasitoid *idiobionts*, but some species are *koinobionts*. Miscogasterinae are larvo-pupal endoparasitoids of dipteran leaf miners. Eunotinae (e.g. *Moranila*) are predators on Coccoidea eggs within the female body (Boucek and Rasplus 1991).

Signiphoridae. A small family of tiny chalcids (0.5–2 mm) comprising only 8 European species, one of which is an introduced hyperparasitoid (*Chartocerus*) (Woolley 1988). Signiphoridae are known as parasitoids (sometimes hyperparasitoids) of cyclorrhaphous dipterans, scale-insects (Coccoidea) or white-flies (Aleyrodidae).

Torymidae. A medium-sized family that includes about 350 European species (Grissell 1995, Grissell 1999), of which 13 are considered as alien *to* Europe. Most of the alien species (12) belong to the genus *Megastigmus* and are considered pest of conifer seeds (Roques and Skrzypczynska 2003). Most torymines are idiobiont ectoparasitoids of gall-makers (Cynipidae and Cecidomyiidae) and other endophytic insects but most Megastigminae are specialist phytophages. *Megastigmus* females lay their eggs in the ovules of conifers before fertilization has taken place (Roques and Skrzypczynska 2003) (Figure 12.9). *Megastigmus* biological habits have been shown to be particularly prone to invasion. Since most of their development takes place within seed, their presence is usually overlooked in traded seed lots, the infested seeds showing up only when X-rayed (Figure 12.10). In addition, insect are able to become dormant during the larval stage, for up to 5 years (prolonged diapause) following the annual size variations of the seed crop, thus broadening the chances that adult emergence will occur under favourable circumstances near a suitable new host. Moreover, some species such as the Douglas-fir seed chalcid, *M. spermotrophus,* appear capable of preventing the abortion of unfertilized seeds. The invasive insect larva may thus achieve its development in unpollinated, unfertilized seeds by altering the physiology of the ovule so that it allocates *de novo* resources to the larva (von Aderkas et al. 2005).

Trichogrammatidae. A moderately-sized family containing about 150 European species. The nine alien species belong mostly to three genera: *Trichogramma*, *Oligosota*, *Uscana* and have been introduced to Europe for the control of agricultural pests (Lepidoptera and Coleoptera) (Pintureau 2008). Trichogrammatids are primarily solitary or gregarious endoparasitoids of insect eggs (mostly Lepidoptera, Hemiptera, Coleoptera) and can sometimes develop as hyperparasitoids.

Ichneumonoidea

Ichneumonidae. This is the first megadiverse Apocrita family in Europe with about 5500 species, six of them are considered as alien *to* Europe. These species have been in-

tentionally introduced for biological control. The family is divided into more than 30 subfamilies. Consequently, the biology of ichneumonids is extremely diverse. Ichneumonids mostly parasitize the immature stages of the Holometabola, and are frequently associated with Lepidoptera and sawflies (Hymenoptera). Ectoparasitism is considered the primitive condition and endoparasitism has evolved several times independently within the family.

Braconidae. Braconids represent the second megadiverse family with nearly 3500 European species, 16 of which are considered as alien. Altogether, Ichneumonoidea may account for nearly 10000 species in Europe. Like ichneumonids, braconids exhibit a large range of biological characteristics. They are mostly parasitoids of other insects. Some of the braconid groups are larvo-nymphal *koinobiont* parasitoids; others are *idiobiont* ectoparasitoids. Introduced species are mostly *koinobiont* endoparasitoids and are associated with aphids (Aphidiinae), moths (Miscogasterinae), and fruit flies (Opiinae).

Ceraphronoidea

Ceraphronidae. A small family represented by 100 European species, only one of which is considered as alien, *Aphanogmus bicolor*. Their biology is poorly known but some species are endoparasitoids of nematocerous dipterans whilst others attack Thysanoptera or Neuroptera. Some species are considered as antagonists of biological control agents since they are parasitoids of predaceous midges or hymenopteran primary parasitoids.

Cynipoidea

Cynipidae. A medium-sized family confined to the Holarctic and containing 350 European species. Only the chesnut gall wasp, *Dryocosmus kuriphilus*, is alien *to* Europe (Figure 10.8). Six more species, mostly from the genus *Andricus*, are considered as aliens *in* Europe. Most Cynipinae are gall inducers on *Quercus*, *Rosa* and some Compositae but others (Synergini) are inquilines.

Figitidae. This medium-sized family contains ca. 400 species in Europe, the family as presently understood includes the previous Eucoilidae, Charipidae and Anacharitidae (Ronquist 1995). Only one species (*Aganaspis daci*) is considered as alien and has been introduced to Europe for the control of fruitflies. Figitid larvae develop as internal parasitoids of other endophytic insect larvae. The hosts are mostly dipteran larvae but Charipinae Alloxystini are hyperparasitoids of aphids through Braconidae Aphidiinae and Aphelinidae. The egg is deposited inside a young host larva, which continues to develop normally (koinobionts), the parasitoid larvae emerges before the host death and can achieve its development as an ectoparasitoid.

Platygastroidea

Platygastridae. A medium-sized family with about 500 species in Europe but only two (*Amitus* spp.) are considered as alien, having been introduced into Europe for the control of whiteflies. Many Platygastridae are endoparasitoids of gall-making dipterans whilst others attack immature hemipterans or ant larvae. The biology of most species remains largely unknown. Some species are *thelytokous* and very few polyembryonnic. The larvae have an uncommon appearance and superficially resemble cyclopoid copepods.

Scelionidae. A medium-sized family that includes about 600 species in Europe, three of them considered as alien. Scelionids are primarily endoparasitoids in a wide variety of insect eggs (few on other arthropods), more rarely hyperparasitoids. Introduced species attack Hemiptera or Lepidoptera eggs and have been used for pest control. The family has been synonymized with Platygastridae but we still keep it apart for consistency (Murphy et al. 2007).

Suborder Apocrita Aculeata

Chrysidoidea

Bethylidae. A medium-sized family represented by about 230 species in Europe. Four species are considered alien. *Cephalonomia waterstoni*, *Holepyris sylvanidis* and *Plastanoxus laevis* are cosmopolitan. They were introduced into Europe with stored products. *Laelius utilis* is a parasitoid of *Anthrenus*. Bethylidae mainly attack larvae of Lepidoptera and Coleoptera. The female stings and paralyses the host, and then lays several eggs on its skin. Larvae develop as ectoparasitoids. For a few species, females tend the eggs and developing larvae. Pupation occurs next to the host remains.

Chrysididae. A medium- sized family that comprises 420 European species. Cuckoo- wasps are parasitoids or kleptoparasitoids of Aculeate wasps. The nests of the host are sought out by the female chrysid that oviposits into the host cells. A true parasitoid larva develops as an ectoparasitoid on the host larva whilst a kleptoparasite larva kills the egg or the young larva of the host before consuming the stored food. One East European species introduced in western parts of Europe, *Chrysis marginata*, is considered as alien *in* Europe (Pagliano et al. 2000).

Dryinidae. A medium-sized family that comprises about 100 species in Europe. All dryinids are parasitoids of immature and adult Hemiptera Auchenorrhyncha. The larva is rather endoparasitoid than ectoparasitoid during the last instars, forming a bag (*thylacium*) constituted by the exuviae of the parasitoid and bulging from the host abdomen. Only one species alien *to* Europe, *Neodryinus typhlocybae*, was introduced in northern Italy and subsequently in France for biological control of the Nearctic planthopper *Metcalfa pruinosa* (Hemiptera, Flatidae) (Malausa et al. 2003, Malausa et al. 2008).

Apoidea

Apoidea represents a superfamily including more than 2000 species in Europe. Depending on the classification used, the group comprises seven families (ancient subfamilies of the single family Apidae) to eleven families if sphecid wasps, the sister group of bees, are included (Sharkey 2007). Here we followed the more recent classification system and adopted a subdivision into several families. Bees are flower visitors and efficient pollinators of angiosperms. Their larvae are phytophagous and develop on a mixture of pollen and nectars. Bees are now recognized as an important group of ecosystem engineers that modulate resources availability (i.e. plants) to other organisms (Jones et al. 1994). Two families of bees contain alien species in Europe. Sphecid wasps comprise 4 families of wasps that feed their progeny with a wide range of preys (mainly insects or spiders), depending on genera. All alien species belong to the family Sphecidae.

Apidae. This small family of *eusocial* bees includes social species, with colonies attaining large sizes. It comprises less than 70 species in Europe, all except one (*Apis meliffera*) belonging to the genus *Bombus*. Some of these pollinator species have been introduced from some parts of Europe into other European regions for crop pollination purposes and honey production.

Megachilidae. This family comprises about 480 species in Europe, two are considered as alien. The alfalfa leafcutter bee, *Megachile rotundata*, is a west European species that has been used commercially for pollination of alfalfa, and introduced in Russia. *Osmia cornifrons* is an alien species that has been introduced from Japan into Denmark for pollination of fruit trees. Megachilidae nest in burrows in soil or in pithy stems. A few species build stony mud nests. Cells of Megachilidae are made of foreign materials (leaf pieces for *Megachile* species) brought into the nest.

Sphecidae. This family in its narrow sense comprises about 70 species, four of which are alien species accidentally introduced into Western Europe from North America (*Sceliphron caementarium* and *Isodontia mexicana*) or from Asia (*S. curvatum* and *S. deforme*). Adults of most species (e.g., *Isodontia*) prey on orthopteroids but some of them, such as *Sceliphron* spp., catch Araneae. While *S. deforme* has possibly not established in the Balkans, both other species became established and threaten autochtonous species of *Sceliphron* (Cetkovic et al. 2004). While *Isodontia* puts its preys in pre-existing cavities, *Sceliphron* are mud-daubers that often built their nests in or around buildings (Bitsch and Barbier 2006, Bitsch et al. 1997).

Vespoidea

Formicidae. This family includes about 650 species in Europe, 42 of which are alien *to* Europe, one is cryptogenetic and seven are European species introduced into other areas of Europe. Ants exhibit a remarkable range of life histories. They have colonized most habitats and form colonies of variable sizes in the soil, plant debris, trees and infrastructures of human origin. The nest contains one to several reproductive females as well as workers and broods. Males are produced seasonally. Mating usually takes

place outside the nest but may occur inside the nest. In Europe, the argentine ant *Linepithema humile* (Mayr) is extremely abundant throughout the Mediterranean basin, causing economic damage by fostering some hemipteran pests and upsetting the action of natural enemies; However, it may occasionally act as a beneficial natural enemy in forest ecosystems (Way et al. 1997).

Vespidae. This medium-sized family comprises 300 species in Europe classified into four subfamilies: Masarinae, Eumeninae, Polistinae and Vespinae (22 species). Vespinae are social wasps that built aerial or subterranean nests made of carton and composed of several combs protected by an envelope. Recently, a hornet species alien *to* Europe, *Vespa velutina nigrithorax,* was accidentally introduced from Asia into southern France (Haxaire et al. 2006, Villemant et al. 2006) (Figure 10.11). The European yellowjackets, *Vespula germanica* (Fabricius, 1793) and *V. vulgaris* (Linné, 1758) were introduced to Iceland from continental Europe, the last into Feroe Islands (Olafsson 1979).

For nine families the number of alien species exceeds 5% of the species known in Europe (Figure 12.1). Four of these families are small (Agaonidae, Signiphoridae, Siricidae and Sphecidae) and consequently the number of alien species is marginal. However Aphelinidae, Encyrtidae, Trichogrammatidae and Formicidae are medium-sized families comprising between 150 and 700 species and consequently the number of alien taxa is relatively important. Interestingly, the number of alien Aphelinids introduced into Europe for biological control represents about one third of the specific diversity of the family in Europe. Aphelinidae, Encyrtidae and Trichogrammatidae, three families largely used for biological control, rank among the top five in terms of proportion of alien species in the European fauna. Aphelinidae and Encyrtidae are mostly biological control agents of the three mealybug families that include most of the pest species alien to Europe (Diaspididae, Pseudococcidae and Coccidae; see Chapter 9.3). Finally, Formicidae also include a large proportion of alien species to Europe and represent a major group of alien species to Europe.

12.3. Temporal trends

First records in Europe are known for 262 of the 286 hymenopteran species alien *to* Europe (92%). Dates given here are relatively imprecise, as most species may have been introduced two to five years before they were reported. Furthermore, we did not try to check all literature and collections in order to report the dates of first interception within Europe.

The number of new records per time period shows an exponential increase in the number of alien Hymenoptera to Europe during the last 200 years (Figure 12.2). The mean number of new records of alien hymenoptera varies from less than one species per year during the period (1800–1924) to about 5 species per year between 1975 and 2000. Interestingly, we observed a decrease in the number of Hymenoptera reported during the last 10 years. This overall increase in the number of introduced species also corresponded to an increase in the number of hymenopteran families newly found in Europe.

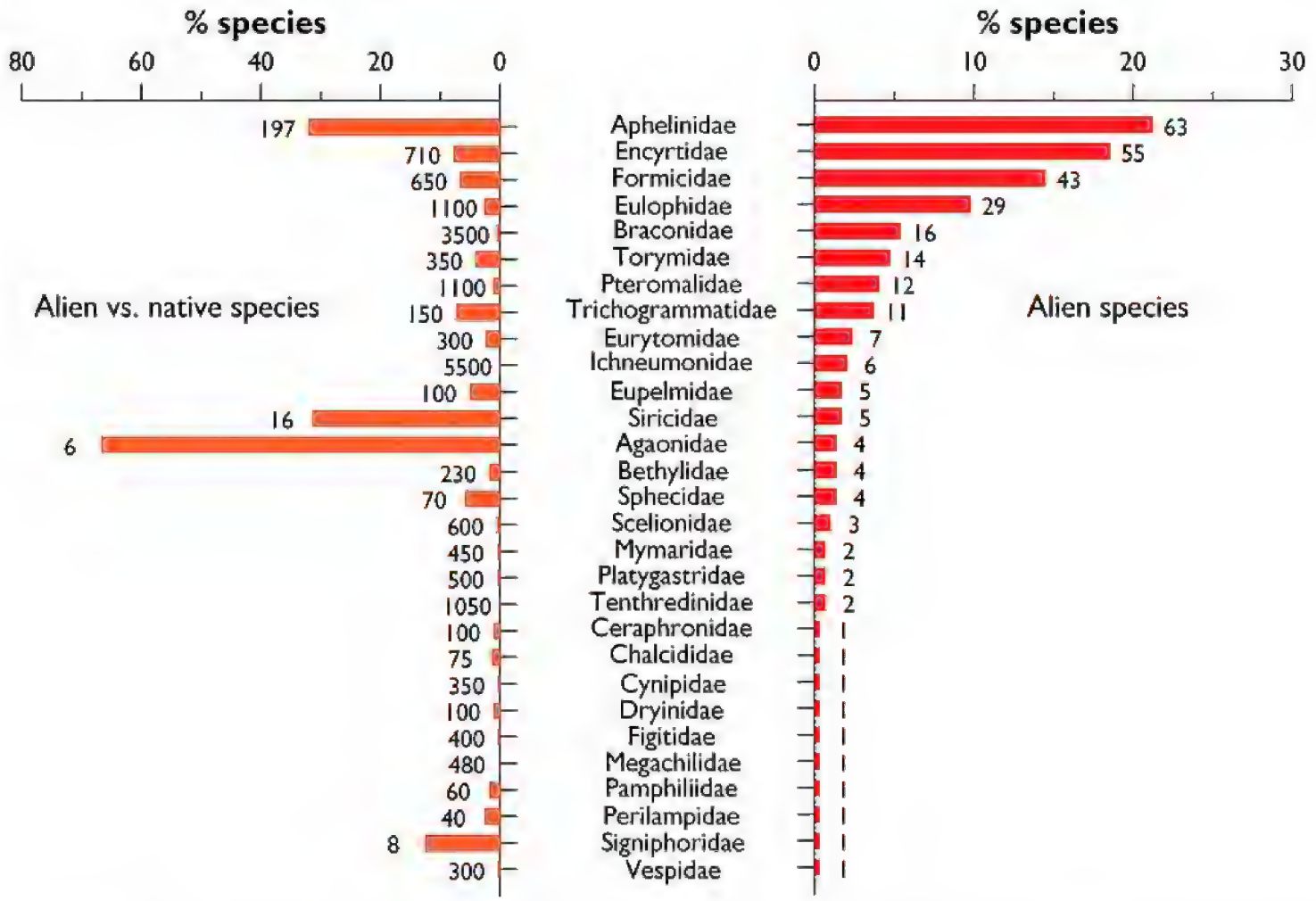

Figure 12.1. Taxonomic overview of the alien Hymenoptera. Right- Relative importance of the hymenopteran families in the alien entomofauna. Families are presented in a decreasing order based on the number of alien species. Species alien *to* Europe include cryptogenic species. The number over each bar indicates the number of alien species observed per family. Left- Percentage of aliens vs. total species in each Hymenoptera family in Europe. The number over each bar indicates the total number of species observed per family in Europe.

From 1800 to 1924 (125 years) only 35 species, representing 8 families, of alien hymenoptera were reported in Europe. Most of them are biological control agents or ants. Only one species of chalcid wasp (furthermore a hyperparasitoid) is reported from that period while Chalcidoidea is the most diverse group of alien Hymenoptera. However, during that period of time the European fauna was still poorly known and little studied (which is still the case for the majority of families) and the number of alien species is likely to have been underestimated. Nevertheless, over 1/3 of the alien ant species presently known in Europe were introduced between 1847 and 1929.

About 79% of the alien Hymenoptera were introduced in Europe in the last 60 years. During that period of time, 61.5% of the phytophagous alien and only 38.3% of the predator alien were introduced into Europe. Among the three most diverse families of alien Hymenoptera (namely Formicidae, Aphelinidae and Encyrtidae), Formicidae exhibited a relatively stable pattern, regarding the number of introductions per year over time, varying between 0.08 and 0.36, with a maximum of introductions during the periods 1925–1949 and 1975–1999 (Figure 12. 3). Aphelinids and encyrtids both show a relatively similar pattern, but somewhat different to the pattern exhibited by ants. These two families, largely used in biological control, showed a peak of introduc-

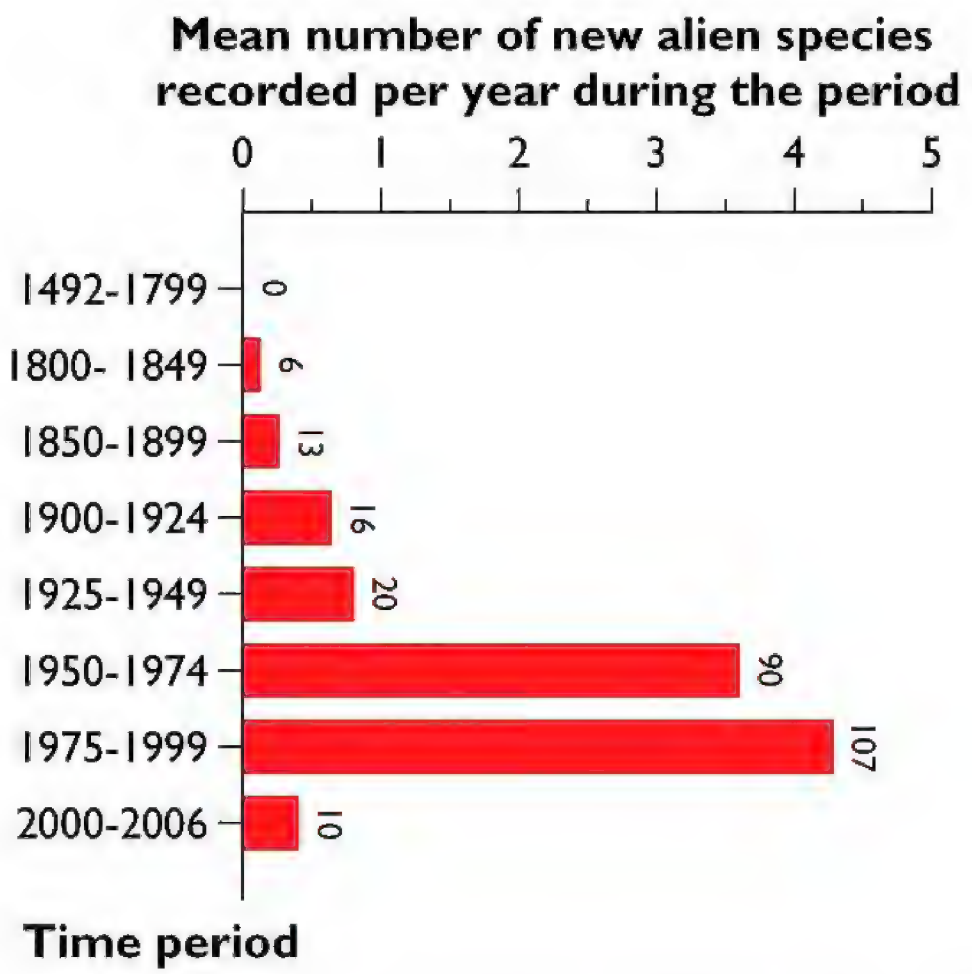

Figure 12.2. Temporal trend in number of alien Hymenoptera to Europe per period of 25 years from 1492 to 2006. Cryptogenic species excluded. The number above the bar indicates the number of species introduced.

tions during the period 1950–1999 (between 0.52 and 1.32 species per year), which roughly corresponds to the 'golden years' of biological control. More specifically, our analysis showed that 77.5% of the total number of parasitoids alien *to* Europe were introduced between 1950 and 1999. In the last 10 years, the rate of introduction drops to less than 0.1 species per year. This trend is probably due to both the decreasing interest in research on biological control and to the growing concern over possible nontarget effects of biological control.

12.4. Biogeographic patterns

Origin of alien species

We could ascertain a region of origin for 272 (95.1%) alien wasp species introduced to Europe. Overall there are no major difficulties in identifying the areas of origin of these wasps. The distribution of the genera of the hosts or the plant-hosts and also the origin of the taxonomists describing these species provide evidence of likely origins. However, for subsequent spread within Europe it is difficult, without genetic analyses, to separate spreading from adjacent countries from independent colonization events.

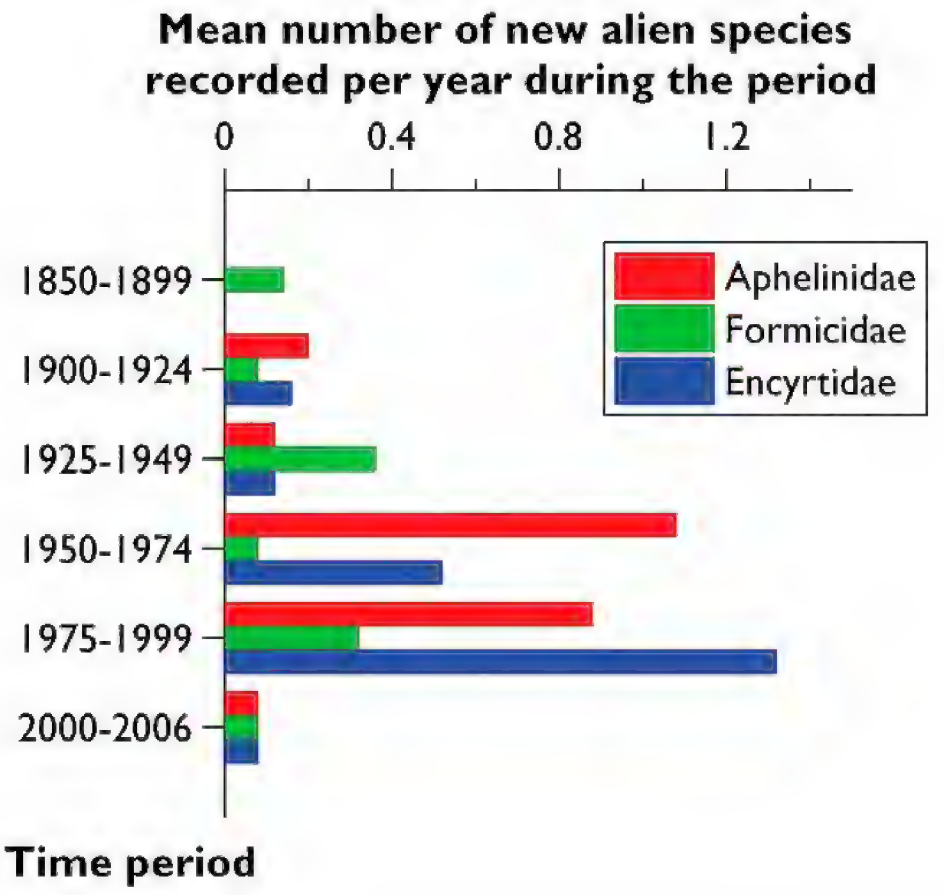

Figure 12.3. Rates of introduction of the three most diverse families of invasive Hymenoptera during the two last centuries.

North America provided the greatest part of alien Hymenoptera occurring in Europe (96 species, 35.3%), followed by Asia (84, 30.9%) and Africa (49, 18%) (Figure 12.4). This pattern is similar to the one found for Diptera (see Chapter 10) but differs from that observed in most other insect groups. Whatever the main areas of origin, trends of introduction are similar over time, and there is no evidence of a change in the origin of alien species through time (Figure 12.5). The only difference seemed to be a decrease of the afro-tropical species in the last 30 years, whereas rates of introduction still increased for both North America and Asia. However it must be noted that origins of alien species can differ from one country to another and general trends are not supported in all countries. Israel for example received more species from Asia and Africa than from North America (Roll et al. 2007).

Interestingly, the composition of the introduced guilds originating from different continents differed taxonomically. The alien guilds introduced from North America contains several phytophagous species (Siricidae, Torymidae, Eurytomidae) and several species of Ichneumonoidea that are absent from oriental invader guilds. Overall, phytophagous aliens mostly originate from North America and temperate Asia. This is the case for xylophagous Siricidae, most *Megastigmus* seed-feeders (Torymidae), several Eurytomid species. Introduced plants (e.g. *Ficus* and *Eucalyptus*) came into Europe with species of their phytophagous guilds (Agaonid and Eulophidae gall-makers). Alien Formicidae originates from Africa (10 species), Asia (14) and South America (7) while only two were introduced from North America. South American ants mostly originated from areas with Mediterranean-like climate. Parasitoid wasps originated from all continents with no particular trends.

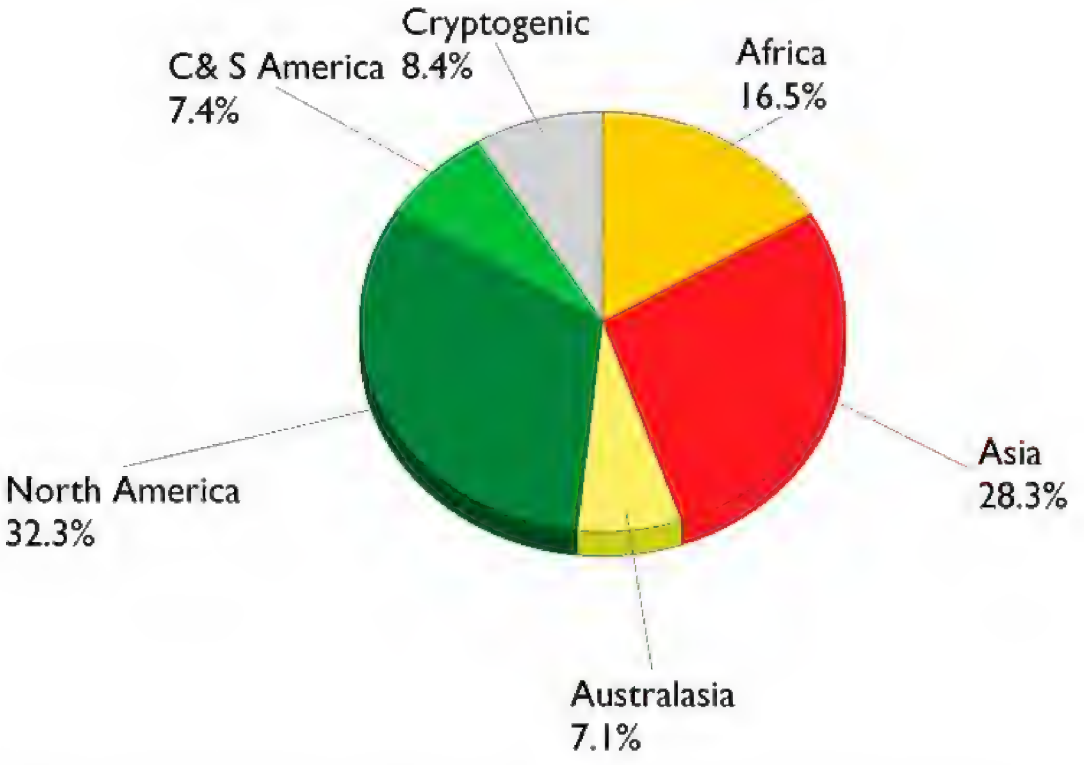

Figure 12.4. Origin of the 286 alien species of Hymenoptera established in Europe.

Distribution of alien species in Europe

Alien Hymenoptera species and families are not evenly distributed throughout Europe and large differences exist between countries (Figure 12.6, Table 12.3). However, results might have been influenced by large variations in the number of taxonomists involved, as well as by the intensity of the studies and of the samplings conducted in different regions. Little information is available for some countries of central and north-eastern Europe and consequently these areas appear to host comparatively few alien species of Hymenoptera.

Continental Italy hosts the largest number of alien Hymenoptera (144 spp.), followed by continental France (111 spp.) and continental Spain (90 spp.). Bosnia, Andorra and Latvia are the countries from which the lowest number of invasive Hymenoptera has been reported so far, with only one alien species. No correlation with the country surface area has been found but there is a latitudinal trend of decreasing number of alien species to Europe from southern to northern Europe

As most of the alien hymenopterans are biological control agents, they were mostly introduced in one or few countries by national research projects that attempted to control target pest. Large-scale European projects for biological control are rare and consequently wasps have been introduced on a local scale.

About 150 alien species (i.e., more than 50% of the total species) have been reported from only one or two countries. In contrast, 31 species are reported from at least 10 countries, among them 13 of the 36 species were introduced before 1924. These aliens mostly belong to the three diverse families of alien Hymenoptera (namely Aphelinidae, Encyrtidae and Formicidae). Most of these widespread alien wasps were parasitoids introduced for biological control. For example, *Aphelinus mali* against the woolly apple aphid, *Eriosoma lanigerum* (Hausmann); *Aphidius colemani* and *A. smithi* as generalist

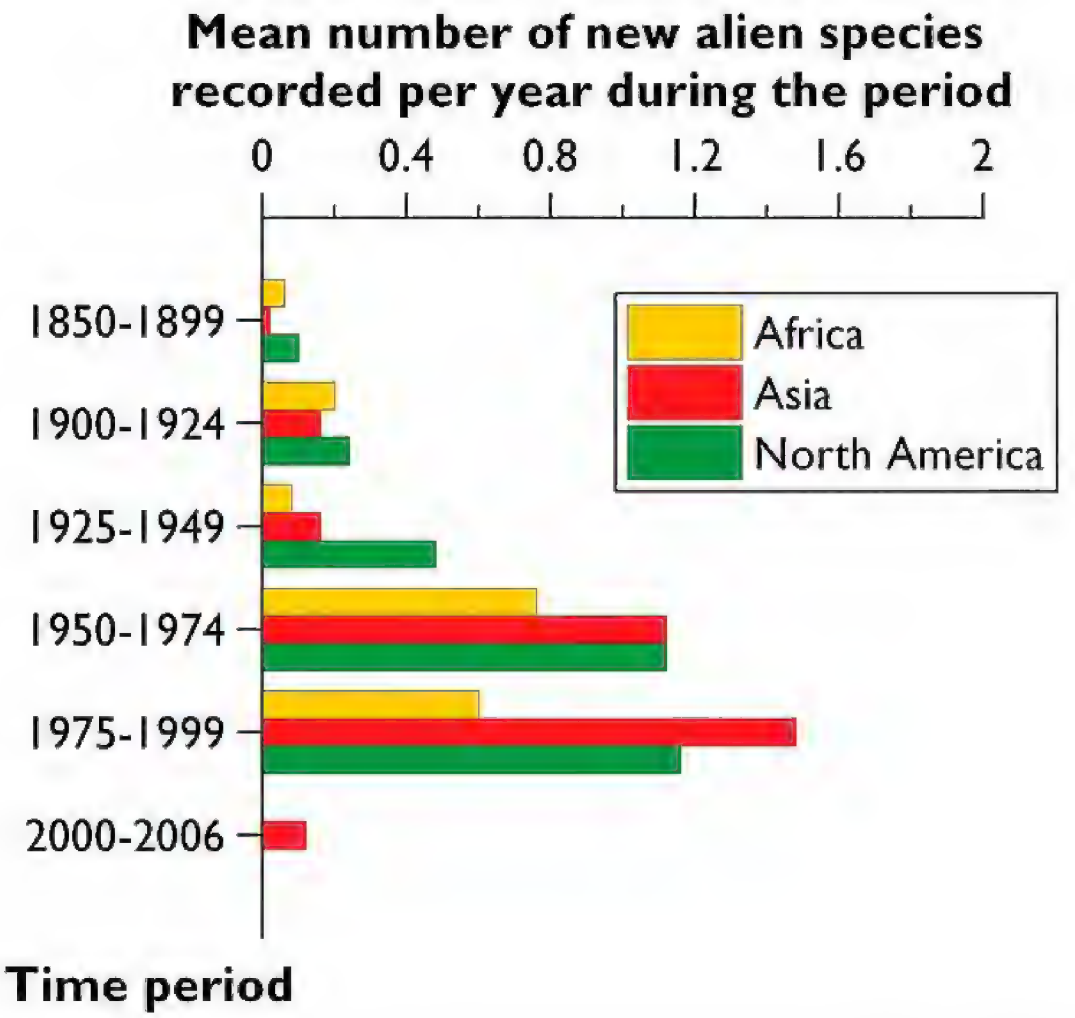

Figure 12.5. Evolution of the rate of alien Hymenoptera from different origin through time.

parasitoids used against several species of pest aphids, i.e., *Acyrthosiphon pisum* (Harris), *Aphis gossypii* Glover and *Myzus persicae* (Sulzer); *Cales noacki* against the aleyrodid *Aleurothrixus floccosus* (Maskell), a pest on *Citrus*; *Encarsia formosa* mostly as a biological control agent of greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood); *Leptomastix dactylopii* Howard against *Planococcus citri* (Risso); *Aphytis mytilaspidis* as a parasitoid of the oystershell scale, *Lepidosaphes ulmi* (L.), and some other diaspidid scales; *Eretmocerus eremicus* as a parasitoid of the *Bemisia* complex (Hemiptera, Aleyrodidae) in the native range; and, *Mesopolobus spermotrophus* against the seed chalcid pest *Megastigmus spermotrophus*.

Only three of the widespread alien Hymenoptera are phytophagous and were introduced during the 19th century (*Megastigmus spermotrophus, Nematus tibialis, Sirex cyaneus*). Seven species of Formicidae appear widely distributed in Europe: *Hypoponera punctatissima* (31 countries), *Lasius neglectus* (10), *L. turcicus* (15), *Linepithema humile* (17), *Monomorium pharaonis* (23), *Paratrechina longicornis* (13), *Pheidole megacephala* (14)

12.5. Main pathways to Europe

Intentional introductions represent a large proportion of the introduced species in Europe (180 of 286, 63%) and this is mostly due to the high number of introduced

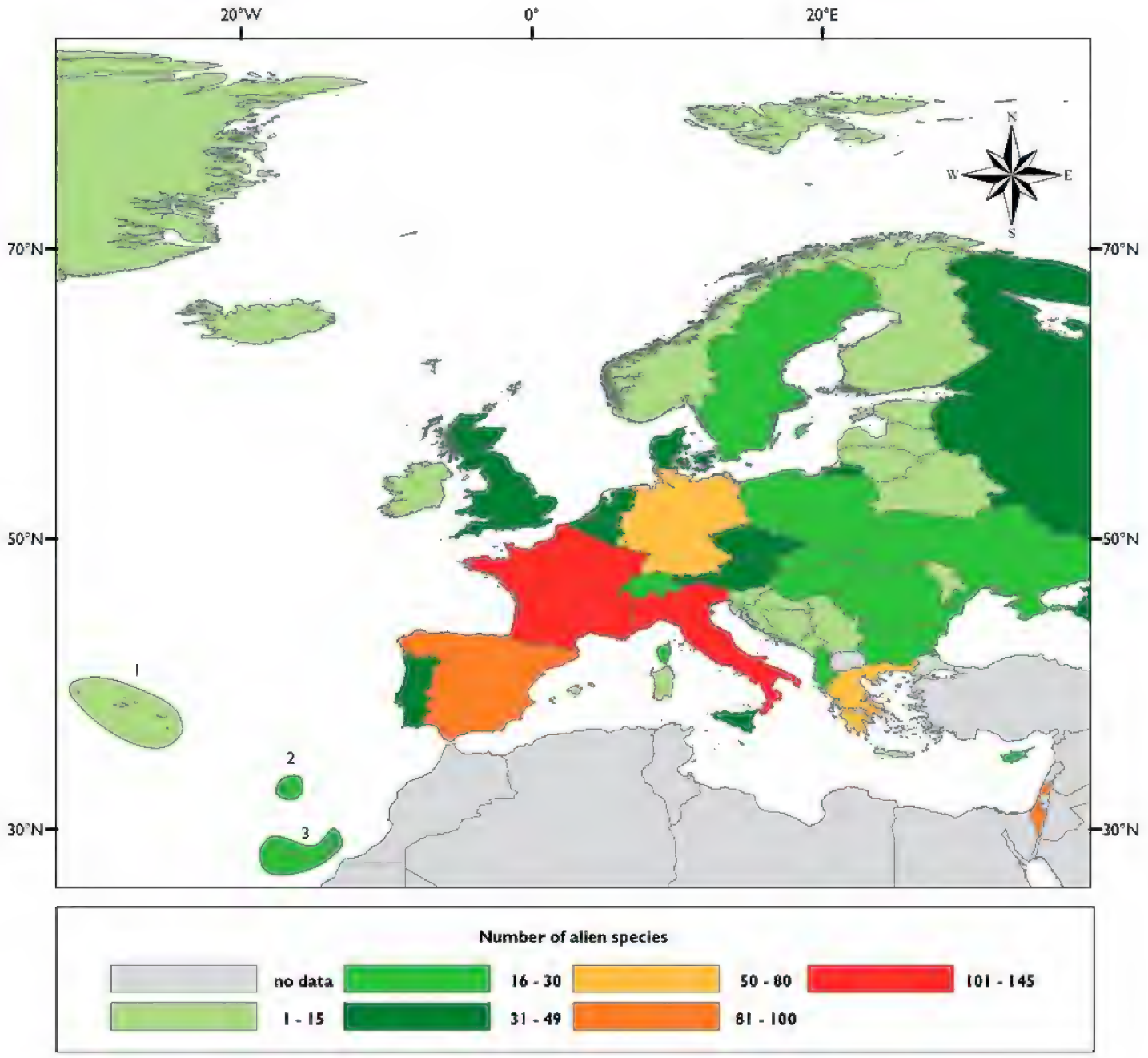

Figure 12.6. Colonization of continental European countries and main European islands by hymenopteran species alien to Europe. Archipelagos: **1** Azores **2** Madeira **3** Canary Islands.

biological control agents. Among the 106 species clearly accidentally introduced in Europe, 32 (30.1%) are phytophagous species, only 24 (22.6%) parasitoids or hyperparasitoids that were sometimes unintentionally introduced with their parasitic hosts although the real status of some of these parasitoids is difficult to ascertain, while the majority (47 species; i.e., 44.3%), are social Hymenoptera and Sphecidae.

Several species are cryptogenic and represent ancient introductions in Europe, mostly with stored products. Identifying the origin of accidental introductions is not easy but clearly introductions of plants for planting (e.g. cultivated conifers, ornamental trees) and plant seeds appeared to be the main pathways of introduction for phytophagous Hymenoptera. Thus, the lack of regulatory measures for seed imports in Europe probably resulted in the repeated establishment of alien species of *Megastigmus* seed chalcids since the beginning of the 20th century. Aliens presently represent 43% of the total fauna of tree seed chalcids in Europe (Roques and Skrzypczynska 2003). The development of trade in plant material through the Internet is likely to increase

this process because there is less control, especially for tree seeds which can be moved quite freely all over the world.

12.6. Most invaded ecosystems and habitats

Most of the habitats colonized by Hymenoptera alien *to* Europe correspond to habitats strongly modified by humans (Figure 12.7). About half of the species occur in agricultural and horticultural habitats and this proportion reaches 2/3 of the species if greenhouses are considered. Only 20% of the aliens to Europe occur in woodland and forest habitats. However, the proportion is reversed if we consider Hymenoptera alien *in* Europe; in this case, half of the translocated species are phytophagous pests of trees.

12.7. Ecological and economic impact

The ecological impacts of alien invertebrate species have been recently reviewed by Kenis et al. (2009) and Hymenoptera represent well all impact categories described in this review. Biological control programmes against pests, using introduced parasitoids, were initiated in Europe about 100 years ago. These programs using relatively host-specific parasitoids are long supposed to decrease the risk to nontarget species, however there is increasing concern about the ecological costs of biological control (Louda et al. 2003, Simberloff and Stiling 1996). All introduced natural enemies present a certain

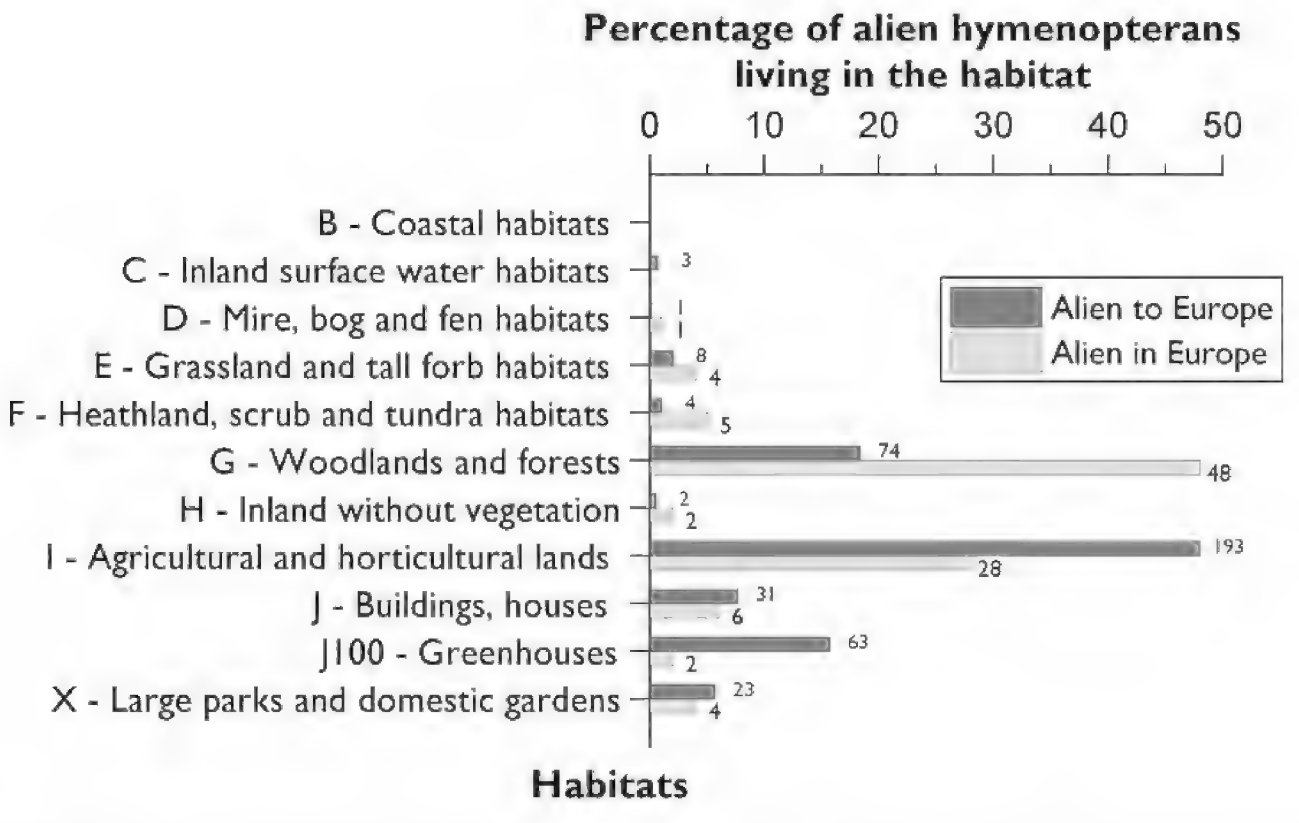

Figure 12.7. Main European habitats colonized by the species of Hymenoptera alien *to* Europe and alien *in* Europe. The number over each bar indicates the absolute number of alien hymenopterans recorded per habitat. Note that a species may have colonized several habitats.

degree of risk to non-target species and there is clear evidence of non-target effects (Lynch and Thomas 2000). Indeed, some butterfly populations have suffered a range reduction likely due to parasitism from an introduced wasp (Benson et al. 2003a, Benson et al. 2003b). Recently, Babendreier et al. (2003) found in laboratory experiments that *Trichogramma brassicae* (a parasitoid largely used against *Ostrinia nubilalis* (Hübner) on maize) parasitizes eggs of 22 out of 23 lepidopteran species tested, including several which are listed on the Swiss red list of endangered species. Because researchers have not looked systematically for non-target effects, they are probably underestimated in Europe. Biological control is potentially a valuable control strategy against invasions of alien insect pest species in agricultural and forest ecosystems. Nevertheless, post-release monitoring of biological control agents on target and nontarget species has yet to be developed. This is an ethical responsibility of scientists (Delfosse 2005) and it could help to resolve uncertainties in the impact of releases.

One of the most pernicious effects of introduced ants is the elimination or displacement of native ants and potential cascading effects on other trophic levels. Indeed, invasive ant species have huge colonies that exploit local resources and therefore represent a considerable threat to native ants. This ecological advantage of invasive ant species is partly attributed to their unicoloniality that promotes high worker densities and to the presence of several queens that accelerate colony growth and propagation

Figure 12.8. Chestnut gall induced by the chestnut gall wasp, *Dryocosmus kuriphilus* (Credit: Milka Glavendekić).

Figure 12.9. Female of cedar seed chalcid, *Megastigmus schimitscheki*, ovipositing on a cedar cone. (Credit: Gaëlle Rouault).

(Giraud et al. 2002), sometimes coupled with diet plasticity allowing them to exploit human residues.

Introduced alien parasitoids have also been suspected to displace native parasitoids by competition; however, reliable examples are still rare. One reported case in Europe is the probable displacement of *Encarsia margaritiventris* (Mercet), a parasitoid of the whiteflies *Aleurotuba jelineki* (Frauenfeld) following the introduction of *Cales noacki* (Viggiani 1994b).

There is still debate about the extent to which an introduced bee could alter native pollinator communities. Some studies clearly show that introduction of non-native bees may have strong impacts on local communities of bees (Goulson 2003), but their effects have been poorly documented in Europe. However, it is important to keep in mind that generalist *polylectic* bees (i.e. *Apis*, *Bombus*) may compete with native flower visitors (bees, wasps, butterflies, moths, beetles and flies) (Ings et al. 2006), as well as competing for nest sites. There is also evidence that introduced bees could bear pathogenic, commensal and mutualistic organisms, that could be co-introduced and transmitted to native Apidae (Goka et al. 2001). Exotic bees could also disrupt native pollinator services and could be the only pollinators of weeds, improving their seed set and spread.

Genetic impacts of Hymenoptera are clearly underestimated and there is strong risk that introduced species may hybridize with localy adapted populations. This case has been reported for *Bombus* and *Apis*, and there is a strong risk that commercial and native subspecies will hybridize with alien ones (Goulson 2003, Ings et al. 2005,

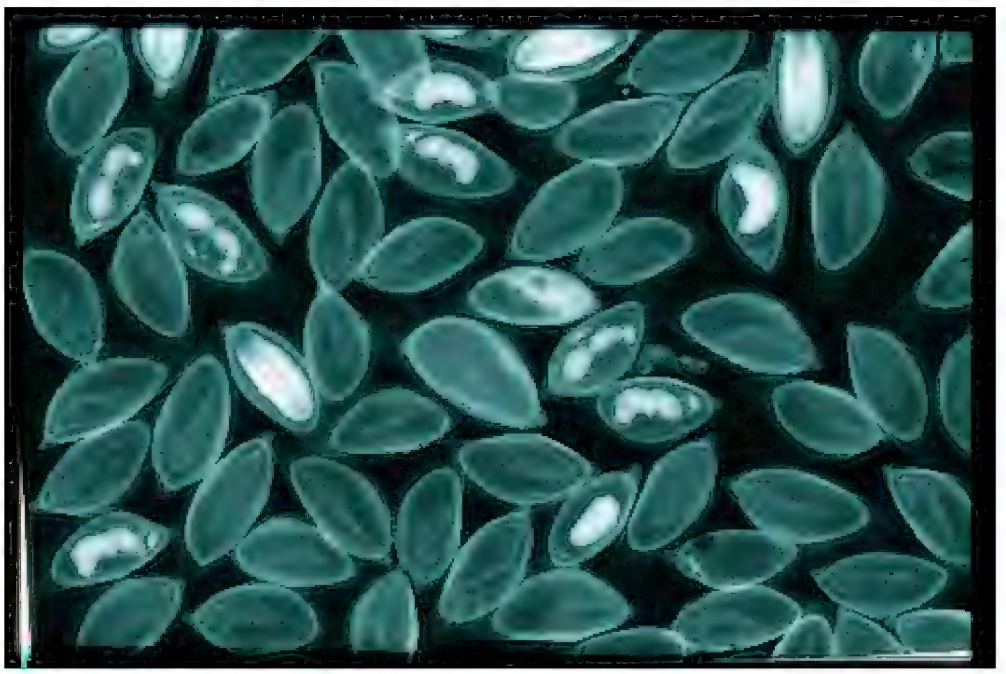

Figure 12.10. X-ray picture of Douglas fir seeds showing seeds infested by larvae and pupae of the Douglas-fir seed chalcid, *Megastigmus spermotrophus* (Credit: Jean-Paul Raimbault).

Figure 12.11. Nest of Asian Hornet, *Vespa velutina nigrothorax* (Credit: Claire Villemant)

Kanbe et al. 2008). Introduction of Mediterranean subspecies of *Apis mellifera, A. m. carnica* and *A.m. ligustica,* in northern Europe has led to extended gene flow and introgression between these subspecies and the native black honeybee, *A. m. mellifera* in different parts of Europe (De La Rùa et al. 2002, Jensen et al. 2005).

Introduced phytophagous Hymenoptera may also have strong economic and ecological impact. During mass-outbreaks they defoliate trees, reduce their growth and lead, sometimes, to their death. This is the case for diprionid outbreaks (De Somviele et al. 2004, Lyytikainen-Saarenmaa and Tomppo 2002) as well as for xylophagous siricids that threaten pine plantations (Yemshanov et al. 2009).

Economic impacts of alien Hymenoptera have received little attention In Europe and consequently are clearly underestimated. However introduced alien ant species account for over $120 billion of annual costs in the United States alone (Gutrich et al. 2007, Pimentel et al. 2000, Pimentel et al. 2005, Vis and Lenteren 2008). Introduced siricids in the United States are considered as an economically serious threat with a total projected loss of more than $ 0.76 billion over 30 years (Yemshanov et al. 2009). The recent introduction in France of Vespa velutina would also have a significant impact on beekeeping because this hornet mainly preys on honeybees (see factsheet 14.62). Additionally displacement of native bees may also lead to important economic costs that are nevertheless difficult to estimate (Allsopp et al. 2008, Gallai et al. 2009, Veddeler et al. 2008).

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Table 12.1. Hymenoptera species alien *to* Europe. List and characteristics. Status: A: Alien *to* Europe; C: cryptogenic species. Country codes abbreviations refer to ISO 3166 (see appendix I). Habitat abbreviations refer to EUNIS (see appendix II). Last update 01/03/2010

Families *Species*	**Status**	**Regime**	**Native range**	**First Record in Europe**	**Invaded countries**	**Habitat**	**Host**	**References**
Agaonidae								
Platyscapa quadraticeps (Mayr, 1885)	A	phyto-phagous	Asia	1968, IL	IL, IT	I2, G	*Ficus*	Koponen and Askew (2002), Lo Verde et al. (1991)
Eupristina verticillata Waterston, 1921	A	phyto-phagous	Asia	1991, ES-CAN	ES-CAN, IT, IT-SIC	I2, G	*Ficus*	Beardsley and Rasplus (2001), Lo Verde (2002)
Josephiella microcarpae Beardsley & Rasplus, 2001	A	phyto-phagous	Asia	1997, ES-CAN	ES-CAN, IT, IT-SIC	I2, G	Gall maker on *Ficus* leaves	Compton (1989), Lo Verde et al. (1991), Wiebes (1980)
Odontofroggatia galili Wiebes, 1980	A	phyto-phagous	Asia	1979, GR-SEG	GR-SEG, IL, IT, IT-SIC	I2, G	*Ficus*	Galil and Eisikowitch (1968)
Aphelinidae								
Ablerus chionaspidis (Howard, 1914)	A	parasitic/ predator	Asia	1972, IT	ES, IL, IT, RS,	G4	Diaspidid scale insects (Hyperparasitoid and parasitoid)	Herting (1972), Herting (1977), Ofek et al. (1997)
Ablerus clisiocampae (Ashmead, 1894)	A	parasitic/ predator	Asia	1953, FR	FR, IT	G4	Diaspidid scale insects and lepidopteran eggs (Hyperparasitoid and parasitoid both of)	Peck (1963), Yasnosh (1978)
Ablerus perspeciosus Girault, 1916	A	parasitic/ predator	Asia	1972, FR	FR, IL, IT, RS, YU	G3, G4	White peach scale, *Pseudaulacaspis pentagona* (parasite)	Battaglia et al. (1994), Herting (1972), Kozarazhevskaya and Mihajlovic (1983), Mendel et al. (1984)

Families *Species*	**Status**	**Regime**	**Native range**	**First Record in Europe**	**Invaded countries**	**Habitat**	**Host**	**References**
Aphelinus mali (Haldeman, 1851)	A	parasitic/ predator	North America	1921, IT	AL, AT, BG, CH, CZ, DE, DK, FR, HU, IL, IT, MD, NL, PT, RO, RU, SI, SK, UA,	I2	Woolly apple aphid, *Eriosoma lanigerum (*Monophagous parasitoid)	Del Guercio (1925)
Aphelinus semiflavus Howard, 1908	A	parasitic/ predator	North America	1953, ES	DE, ES, IL, IT	I,	Aphids (*Acyrtosiphon pisum, Macrosiphum*, etc.)	Herting (1972), Janssen (1961), Thompson (1953)
Aphytis abnormis (Howard, 1881)	A	parasitic/ predator	North America	1953, FR	ES, FR-COR, GR, HU	G4	Diaspidids and coccids scale insects (*Lepidosaphes, Coccus*)	Herting (1972), Peck (1963), Stathas and Kontodimas (2001), Thompson (1953)
Aphytis acrenulatus DeBach & Rosen, 1976	A	parasitic/ predator	Africa	1994, IT	IT	I	Diaspidid scale insects (*Aspidiella zingiberi* and *Rhizaspidiotus donacis*))	Garonna (1994)
Aphytis chilensis Howard, 1900	A	parasitic/ predator	South America	1910, ES	CY, DE, ES, FR, GR, IT-SIC	I, G3, J100	Diaspidid scale insects (*Aspidiotus, Hemiberlesia* etc.)	Alexandrakis and Neuenschwander (1979), Herting (1972), Liotta (1974), Mercet (1911), Thompson (1953), Viggiani (1994a)
Aphytis coheni DeBach, 1960	A	parasitic/ predator	Asia	1959, IL	CY, GR, IL	I	*Chrysomphalus dictyospermi* on *Citrus*	DeBach (1960), Rosen and DeBach (1979), Wood (1962)
Aphytis diaspidis (Howard, 1881)	A	parasitic/ predator	North America	1952, F	AT, CY, ES, FR, GR, IL, IT, NL, PL	I, G3	Diaspidid scale insects	Applebaum and Rosen (1964), Herting (1972), Rosen and DeBach (1979), Thompson (1953)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Aphytis holoxanthus DeBach, 1960	A	parasitic/ predator	Asia	1959, IL	BE, CY, CZ, DE, ES, FR, IL, NL	I, J100	Diaspidid scale insects (*Chrysomphalus ficus*), *Citrus*, *Ficus*, *Musa*, *Cucurbita*	DeBach (1960), Wood (1962)
Aphytis lepidosaphes Compere, 1955	A	parasitic/ predator	Asia	1961, CY	CY, ES, FR, FR-COR, GR, GR-CRE, IL, IT	I	*Lepidosaphes beckii* on *Citrus*	Argyriou (1974), Benassy et al. (1974), Rosen (1965), Rosen and DeBach (1979), Viggiani and Iannaconne (1972), Wood (1962)
Aphytis lingnanensis Compere, 1955	A	parasitic/ predator	Asia	1966, IT	AL, CY, ES, GR, IL, IT	I	*Aonidiella aurantii* and other scales on *Citrus*	Argov et al. (1995), Rosen and DeBach (1979), Viggiani (1994a)
Aphytis melinus DeBach, 1959	A	parasitic/ predator	Asia	1966, IT-SIC	AL, BE, CY, CZ, DE, DK, ES, FR, GR, IL, IT-SIC, IT, PT	I, J100	*Aonidiella aurantii* on *Citrus*	Alexandrakis and Benassy (1981), Inserra (1971), Rosen and DeBach (1979), Viggiani (1994a)
Aphytis mytilaspidis (Le Baron, 1870)	A	parasitic/ predator	North America	1837, FR	BE, BG, CH, CY, CZ, DE, ES, FR, GB, GR, HR, HU, IT, ME, NL, PL, RO, RS, SE, SI, SK, UA,	I, G3, J100	Diaspidid scale insects	Rosen and DeBach (1979), Viggiani (1994a)
Aphytis yanonensis DeBach &Rosen, 1982	A	parasitic/ predator	Asia	1986, FR	FR, GR	I, J100	Scale parasitoidon citrus	Benassy and Pinet (1987)
Cales noacki Howard, 1907	A	parasitic/ predator	C & S America	1970, IT	ES, ES-CAN, FR, GR, IL, IT, IT-SAR, IT-SIC, MT, PT	I, J100	*Aleurothrixus floccosus* on *Citrus*	Carrero (1979), Del Bene and Gargani (1991), Onillon (1973), Spicciarelli et al. (1996)

Families *Species*	**Status**	**Regime**	**Native range**	**First Record in Europe**	**Invaded countries**	**Habitat**	**Host**	**References**
Centrodora speciosissima (Girault, 1911)	A	parasitic/ predator	North America	1943, HU	AT, DE, HU, RU, UA	I	Pupae of dipterous, chalcid and proctotrupids (hyperparasitoid)	Erdös (1953), Herting (1978), Peck (1963), Thompson (1953)
Coccobius fulvus (Compere & Annecke, 1961)	A	parasitic/ predator	North America	1986, FR	FR	I2, J100	Diaspidid scales on ornemental plants and *Citrus*	Benassy and Pinet (1987)
Coccophagoides murtfeldtae (Howard, 1894)	A	parasitic/ predator	North America	1962, IT	IT	I	*Pseudaulacaspis pentagona*	Peck (1963)
Coccophagoides utilis Doutt, 1966	A	parasitic/ predator	North America	1975, GR	GR	I	*Parlatoria oleae* on olive tree	Argyriou and Kourmadas (1979)
Coccophagus bivittatus Compere, 1931	A	parasitic/ predator	Africa	1960, IT	IL, IT	I	*Coccus hesperidum*	Herting (1972), Zinna (1961)
Coccophagus capensis Compere, 1931	A	parasitic/ predator	Africa	1962, IT-SIC	IL, IT-SIC	I	*Saissetia oleae*	Argov and Rössler (1988), Peck (1963)
Coccophagus ceroplastae (Howard, 1895)	A	parasitic/ predator	Asia	1975, FR	FR, IL	I, J100	*Saissetia oleae* and *Ceroplastes floridensis* on *Citrus*	Argov and Rössler (1988), CIBC (1976)
Coccophagus cowperi Girault, 1917	A	parasitic/ predator	Africa	1963, IT	GR, IL, IT	I	*Saissetia oleae* and other coccids, (sometimes hyperparasitoid)	Ben-Dov (1978)
Coccophagus flavoscutellum Ashmead, 1881	A	parasitic/ predator	North America	1962, IT-SIC	IT-SIC	I	*Coccus oleae*	Monastero (1962)
Coccophagus gossypariae Gahan, 1927	A	parasitic/ predator	North America	1990, IT	DE, IT	I	*Gossyparia spuria* (Eriococcidae)	Viggiani (1998), Viggiani (1999), Viggiani and Romagnoli (1995)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Coccophagus gurneyi Compere, 1929	A	parasitic/ predator	Asia	1973, IT	IT	I	*Pseudococcus fragilis*	Viggiani (1975a)
Coccophagus matsuyamensis Ishihara, 1977	A	parasitic/ predator	Asia	1979, IT	IT,	I	*Coccus hesperidum*	Viggiani (1980)
Coccophagus saissetiae (Annecke & Mynhardt,1979)	A	parasitic/ predator	Africa	1978, IL	IL, IT	I	*Saissetia oleae* on *Citrus*	Annecke and Mynhardt (1979b), Mazzone and Viggiani (1983)
Coccophagus scutellaris (Dalman, 1825)	C	parasitic/ predator	Crypto-genic	1826, SE	AL, BE, DE, ES, FR, IL, NL, PT, SE	I, J100	scales on *Citrus*, Vine, *Populus* and others (polyphagous)	Carrero (1980), Faber and Sengonca (1997), Montiel and Santaella (1995), Oncuer (1974), Panis et al. (1977), Paraskakis et al. (1980)
Coccophagus silvestrii Compere, 1931	A	parasitic/ predator	Asia-Temperate	1972, FR	CZ, FR,	I, J100	Various coccids on *Citrus*	Viggiani and Mazzone (1979)
Coccophagus varius (Silvestri, 1915)	A	parasitic/ predator	Africa	1983, IT	IL, IT	I	*Saissetia oleae*	Mazzone and Viggiani (1983)
Encarsia acaudaleyrodis Hayat, 1976	A	parasitic/ predator	Asia	1999, ES-CAN	ES-CAN	J100	Aleyrodidae	Hernández-Suárez et al. (2003)
Encarsia aurantii (Howard, 1894)	A	parasitic/ predator	North America	1941, IT	CH, DE, FR, HU, IT, PL	I, G3	Diaspidid scale insects (polyphagous)	Howard (1895)
Encarsia azimi Hayat, 1986	A	parasitic/ predator	Asia	2001, IT	ES, ES-CAN, IT,	I, J100	Aleyrodidae on various cultivated plants	Gonzalez Zamora et al. (1996), Kirk et al. (1993)
Encarsia berlesei (Howard, 1906)	A	parasitic/ predator	Asia	1906, IT	AL, AT, BG, CH, DE, ES, FR, GR, HR, HU, IT, IT-SAR, IT-SIC, ME, RU, SI, YU	I	*Pseudaulacaspis pentagona*	Ferrière (1961), Howard (1912), Silvestri (1908)

Families *Species*	**Status**	**Regime**	**Native range**	**First Record in Europe**	**Invaded countries**	**Habitat**	**Host**	**References**
Encarsia citrina (Craw, 1891)	C	parasitic/ predator	Crypto-genic	1915, NL	BE, DE, ES, FR, NL	J100	Scals on olive, *Citrus*, etc (polyphagous)	Ghesquière (1933), Smits van Burgst (1915)
Encarsia diaspidicola (Silvestri, 1909)	A	parasitic/ predator	Asia	1962, IT	IT	I	*Pseudaulacaspis pentagona*	Peck (1963)
Encarsia fasciata (Malenotti, 1917)	C	parasitic/ predator	Crypto-genic	1917, IT	CH, DE, ES, FR, IL, IT	I	Scales on *Laurus*, *Citrus*, *Populus*, *Crataegus*, *Malus*	Gerson (1967), Herting (1972), Malenotti (1917), Neuffer (1962), Thompson (1953)
Encarsia formosa (Gahan, 1924)	A	parasitic/ predator	C & S America	1964, BU	AL, AT, BE, BG, CH, CZ, DE, DK, EE, ES-CAN, FI, FR, GB, HU, IE, IL, IT, IT-SAR, IT-SIC, IT, LT, MT, NL, NO, PL, PT, RO, RS, SE, SK	I, J100	Whiteflies	Burnett (1962), Gerling (1966), Kowalska (1969), Lenteren et al. (1976), Scopes (1969), Stenseth (1976), Viggiani (1987)
Encarsia guadeloupae Viggiani, 1987	A	parasitic/ predator	C & S America	2000, ES-CAN	ES-CAN	I	*Aleurodicus dispersus* and Lecanoideus floccissimus	Nijhor, 2000 #587}
Encarsia herndoni (Girault, 1935)	A	parasitic/ predator	Asia	1987, FR	AL, ES, FR-COR, IT, IT-SIC	I, J100	*Insulaspis gloverii*, scale on Citrus	Benassy and Brun (1989), Liotta et al. (2003), Maniglia et al. (1995), Viggiani (1987)
Encarsia hispida De Santis, 1948	A	parasitic/ predator	South America	1992, IT	ES-BAL, ES-CAN , FR, IT,	I, J100	*Bemisia*	Nijhof et al. (2000)
Encarsia inquirenda (Silvestri, 1930)	A	parasitic/ predator	Asia - Temperate	1979, ES	ES, IL, IT	I2	*Lepidospahes glovenii* on *Citrus*, against	Viggiani (1987)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Encarsia lahorensis (Howard, 1911)	A	parasitic/ predator	Asia	1973, IT	FR, GR, IL, IT, IT-SAR, IT-SIC, RU,	I, J100	Citrus whitefly, *Dialeurodes citri* (specific parasitoid)	Pappas and Viggiani (1979), Viggiani (1981), Viggiani and Mazzone (1977a), Viggiani and Mazzone (1978)
Encarsia lounsburyi (Berlese & Paoli, 1916)	A	parasitic/ predator	Africa	1922, IT	AL, CH, CY, ES, ES-BAL, FR, FR-COR, FR, GR, IL, IT, NL, PT	I, J100	*Insulaspis gloverii* scale on *Citrus*	Viggiani (1987)
Encarsia meritoria Gahan, 1927	A	parasitic/ predator	North America	1990, IT	IT, IT-SIC	I	*Bemisia tabaci* on *Gossypium*	Viggiani (1987)
Encarsia pergandiella Howard, 1907	A	parasitic/ predator	Asia?	1978, IT	FR, IL, IT, IT-SIC	I	*Bemisia*	Buijs et al. (1981), Rivnay and Gerling (1987), Viggiani (1987)
Encarsia perniciosi (Tower, 1913)	A	parasitic/ predator	Asia	1946, IT	AL, AT, BG, CH, CZ, DE, DK, YU, FR, GR, GL, IT, IT-SIC, RO, RS, SK, YU	I	San Jose scale	Bénassy et al. (1965), Bénassy et al. (1968), Gambaro (1965), Mathys and Guignard (1962), Neuffer (1962), Neuffer (1968)
Encarsia porteri (Mercet, 1928)	A	parasitic/ predator	South America	1993, IT	IT	I	Aleyrodidae and various insect eggs	Viggiani and Gerling (1994b)
Encarsia protransvena Viggiani, 1985	A	parasitic/ predator	North America	1998, ES	ES, IT	I	Aleyrodidae and scale insects	Giorgini (2001), Polaszek et al. (1999)
Encarsia sophia (Girault & Dodd,1915)	A	parasitic/ predator	Asia	1992, IT	ES, ES-CAN, IL, IT,	I	*Bemisia* and whiteflies	Gonzalez Zamora et al. (1996), Hernández-Suárez et al. (2003), Pedata and Viggiani (1993), Viggiani and Gerling (1994a)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Eretmocerus californicus Howard, 1895	A	parasitic/ predator	North America	1987, IL	DE, ES, IL, IT, MT, PL	I	*Bemisia*	Abd-Rabou (1999), Albert and Schneller (1994), Argov and Rössler (1988), Baraja et al. (1996), Bednarek and Goszczynski (2002), Mifsud (1997)
Eretmocerus corni Haldeman, 1850	A	parasitic/ predator	North America	1963, IT	GR, IT	I	*Siphoninus phillyreae* (Aleyrodidae)	Menteelos (1967)
Eretmocerus debachi Rose & Rosen, 1992	A	parasitic/ predator	North America	1991, IT	IL, IT, IT-SIC,	I	*Parabemisia myricae* on citrus	Rose and Rosen (1992)
Eretmocerus eremicus Rose & Zolnerowich, 1997	A	parasitic/ predator	North America	1994, CZ	BE, CH, CZ, DK, ES, FI, FR, DE, GR, HU, IT, LT, MT, NL, NO, PL, PT, SK	I, J100	*Bemisia, Trialeurodes*	Berndt et al. (2007), Gerling et al. (2001), Gonzalez et al. (2008), Lacordaire and Dussart (2008), Mary (2005), Rose and Zolnerowich (1997), Stansly et al. (2005)
Eretmocerus haldemani Howard, 1908	A	parasitic/ predator	Asia	1968, FR-COR	FR-COR, UA	I	Aleyrodids (*Bemisia, Trialeurodes*) on *Citrus, Solanum*, ..	Chumak (2003), Onillon (1969)
Eretmocerus paulistus Hempel, 1904	A	parasitic/ predator	North America	1970, ES	AL, ES	I	*Aleurothrixus floccosus* in *Citrus* groves	DeBach and Rose (1976a), DeBach and Rose (1976b)
Marietta carnesi (Howard, 1910)	A	parasitic/ predator	Asia	1987, ES	IT, ES	I	Hyperparasitoid	Rosen (1962)
Pteroptrix chinensis (Howard, 1907)	A	parasitic/ predator	Asia	1974, IT	IT, RU	I	*Mytilococcus beckii* on *Citrus*	Liao et al. (1987), Viggiani (1975a)
Pteroptrix orientalis (Silvestri, 1909)	A	parasitic/ predator	Asia	1909, IT	IT	I	*Chrysomphalus dictyospermi*	Viggiani and Garonna (1993)
Pteroptrix smithi (Compere 1953)	A	parasitic/ predator	Asia	1968, IL	IL, IT	I	*Chrysomphalus aonidum*	Flanders (1969), Viggiani (1975a)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Bethylidae								
Cephalonomia waterstoni Gahan, 1931	C	parasitic/ predator	Crypto-genic	Unknown, GB	GB	J	Grain beetles (*Cryptolestes*)	Finlayson (1950)
Holepyris sylvanidis (Brèthes, 1913)	C	parasitic/ predator	Crypto-genic	Unknown, GB	GB	J	*Tribolium confusum (* Larval parasitoid)	Fitton et al. (1978)
Laelius utilis Cockerell, 1920	A	parasitic/ predator	North America	Unknown, SE	SE	J	*Anthrenus*	Gordh and Moczar (1990)
Plastanoxus laevis (Ashmead, 1893)	A	parasitic/ predator	North America	Unknown	ES, FR, IL, IT	J	Various grain beetles (Cucujidae)	Tussac and Blasco-Zumeta (1999)
Braconidae								
Aphidius colemani Viereck, 1912	A	parasitic/ predator	Asia-Temperate	1965, CZ	AL, AT, BE, CH, CZ, DE, DK, ES, FI, , FR, FR-COR, GB, GR, HU, IE, IT, LT, MT, NL, NO, PL, PT, PT-MAD, SE, SK,	E, I1, I2, J100	Aphids in greenhouses	Clausen (1978), Stary (1975), Stary and Remaudiere (1973), Stary et al. (1977){
Aphidius smithi Sharma & Subba Rao, 1959	A	parasitic/ predator	Asia-Temperate	1960, PL	AL, BG, CH, CY, CZ, DE, DK, ES, ES-CAN, FI, GR, HR, HU, IE, IL, IT, IT-SIC, LT, MD, NL, PL, PT, PT-MAD, RU, SK, UA	I	*Acyrthosiphon kondoi* and *A. pisum*	Pennacchio (1989)
Cotesia hyphantriae (Riley, 1887)	A	parasitic/ predator	North America	1953, YU	YU	G4	*Hyphantria cunea*	Glavendekic (2000)
Cotesia marginiventris (Cresson,1865)	A	parasitic/ predator	North America	1993, FR	BE, DE, ES, FR, NL	J100	grasslands (N)-greenhouses (I)	Clausen (1978)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Diachasmimorpha fullawayi (Silvestri, 1912)	A	parasitic/ predator	Africa	Unknown, IT	IT	I	fruit-Infesting Tephritidae	Clausen (1978)
Diachasmimorpha tryoni (Cameron, 1911)	A	parasitic/ predator	Australasia	1932, ES	ES, ES-CAN, IL	I	fruit-Infesting Tephritidae	Clausen (1978)
Heterospilus cephi Rohwer, 1925	A	parasitic/ predator	North America	Unknown, GB	GB	I	*Cephus pygmeus*	Clausen (1978)
Hymenochaonia delicata (Cresson 1872)	A	parasitic/ predator	North America	1933, FR	FR, IT	I	*Cydia molesta*	van Achterberg (1993)
Lysiphlebus testaceipes (Cresson, 1880)	C	parasitic/ predator	Crypto-genic	1965, CZ	AL, BG, CZ, DK, ES, FR FR-COR, IT, IT-SIC, PT	E, I	Aphids	Barbagallo et al. (1983), Costa and Stary (1988), Kavallieratos and Lykouressis (1999), Ortu and Prota (1983), Stary et al. (1985), Steenis (1992), Tremblay et al. (1978)
Macrocentrus ancylivorus (Rohwer, 1923)	A	parasitic/ predator	North America	1930, IT-SAR	FR-COR, IT-SAR,	i	*Ancylis comptana*	Labeyrie (1957)
Microgaster pantographae Muesebeck, 1922	A	parasitic/ predator	North America	Unknown, GB	GB	I	Tortricid moths	Fitton et al. (1978)
Opius dimidiatus Ashmead, 1889	A	parasitic/ predator	North America	Unknown, NL	NL	I1	*Liriomyza trifolii* (Solitary endoparasitoid)	van der Linden (1986)
Pauesia cedrobii Starý & Leclant 1977	A	parasitic/ predator	Africa	1987, FR	FR, IL	G1, I2	*Cedrodium* on *Cedrus*	Fabre and Rabasse (1987), Remaudière and Stary (1993)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Pauesia unilachni (Gahan, 1927)	A	parasitic/ predator	Asia	1930, ES	ES, IT	G3	Grey pine aphid, *Schizolachnus pineti*	Quilis Pérez (1931)
Perilitus vittatae (Muesebeck, 1936)	A	parasitic/ predator	North America	Unknown, DE	DE	I	*Phyllotreta* leaf beetles (adults)	Haeselbarth (2008)
Psyttalia concolor (Szépligeti, 1910)	A	parasitic/ predator	Africa	1914, IT	FR, GL, IT	G4	Fruit-Infesting Tephritidae	Clausen (1978), Delanoue (1960)
Ceraphronidae								
Aphanogmus bicolor Ashmead, 1893	A	parasitic/ predator	North America	Unknown	AT, BE, CH, DK, FI, GR, HR, RS	I	Cecidomyidae	Dessart (1994)
Chalcididae								
Dirhinus giffardii Silvestri,1913	A	parasitic/ predator	Africa	1912, IT	GR, IL, IT	I	Fruits	Greathead (1976), Podoler and Mazor (1981), Thompson (1953)
Cynipidae								
Dryocosmus kuriphilus Yasumatsu, 1951	A	phyto-phagous	Asia-Temperate	2002, IT	CH, FR, HU, IT, SI	G1, I2	*Castanea*	Anonymous (2005), Breisch and Streito (2004), Csoka et al. (2009), Forster et al. (2009), Graziosi and Santi (2008)
Dryinidae								
Neodryinus typhlocybae (Ashmead, 1893)	A	parasitic/ predator	North America	1994, IT	CH, FR, IT, SI	I	*Metcalfa pruinosa*	Malausa (1999), Malausa et al. (2003)
Encyrtidae								
Adelencyrtus aulacaspidis (Brèthes, 1914)	A	parasitic/ predator	South America	1930, FR	BG, CH, CZ, DE, ES, FR, GB, HR, HU, IT, RU, SI, UA	G3, G4	Various Diaspididae	Trjapitzin (1989)
Aenasius flandersi Kerrich, 1967	A	parasitic/ predator	South America	1999, ES-CAN	ES-CAN	I	*Phenacoccus manihoti*	Baez and Askew (1999)

Families *Species*	**Status**	**Regime**	**Native range**	**First Record in Europe**	**Invaded countries**	**Habitat**	**Host**	**References**
Ageniaspis citricola Logvinovskaya, 1983	A	parasitic/ predator	Asia?	1966, IT-SIC	FR, ES, ES-CAN, GR, IL, IT, IT-SIC, PL	I, J100	Citrus leafminer, *Phyllocnistis citrella*, in *Citrus* orchards	Argov and Rössler (1996), Michelakis (1997), Siscaro et al. (1997), Siscaro and Mazzeo (1997), Urbaneja et al. (2000)
Aloencyrtus saissetiae (Compere,1939)	A	parasitic/ predator	Africa	1987, IL	IL	I	*Saissetia oleae* on citrus.	Argov and Rössler (1988)
Anagyrus agraensis Saraswat,1975	A	parasitic/ predator	Asia	1987, IL	IL	I	*Nipaecoccus viridis*	Bar-Zakay et al. (1987)
Anagyrus fusciventris (Girault, 1915)	A	parasitic/ predator	Australasia	1983, IT	BE, DE, DK, ES, FR, DE, IT, NL	J100	pseudococcids on Cycas, coffee, *Citrus*	Viggiani and Battaglia (1983)
Anagyrus sawadai Ishii,1928	A	parasitic/ predator	Asia	1996, IL	IL	I	*Citrus* mealybug, *Pseudococcus cryptus*	Blumberg et al. (1999b)
Anagyrus subflaviceps (Girault, 1915)	A	parasitic/ predator	Australasia	1994, PT	ES, IL, PT	I	Pseudococcids	Simutnik et al. (2005)
Anicetus annulatus Timberlake, 1919	A	parasitic/ predator	North America	1977, HR	AL, HR	I	Scale insects on *Citrus*	Hoffer (1970), Hoffer (1982)
Anicetus ceroplastis Ishii,1928	A	parasitic/ predator	Asia	1989, IL	IL	I	*Ceroplastes floridensis*	Blumberg (1977)
Anthemus hilli Dodd, 1917	A	parasitic/ predator	Australasia	1954, ES	ES	I	*Chionaspis graminis*	Gerling et al. (1980)
Avetianella longoi Siscaro, 1992	A	parasitic/ predator	Australasia	1990, PT	IT-SIC, IT, PT	I, G1	*Phoracantha semipunctata* (Oophagous)	Farrall et al. (1992), Longo et al. (1993), Siscaro (1992)
Bothriophryne fuscicornis Compere, 1939	A	parasitic/ predator	Africa	1972, IL	CZ, IL, SK	I, G	Various Coccidae	Kfir and Rosen (1980)
Clausenia purpurea Ishii,1923	A	parasitic/ predator	Asia	1974, IL	IL, IT	I	Citriculus mealybug *Pseudococcus cryptus*	Guerrieri and Pellizzari (2009), Rosen (1974)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Coccidencyrtus malloi Blanchard, 1964	A	parasitic/ predator	South America	1999, FR	FR, IT	J100	*Diaspis boisduvalii*	Panis and Pinet (1999a)
Coccidoxenoides perminutus Girault, 1915	A	parasitic/ predator	Asia	1956, IT	CY, GB, IL, IT	I, J100	*Planococcus ficus* and *P. citri*	Fry (1989), Noyes and Hayat (1994), Trjapitzin (1978), Viggiani (1975a), Zinna (1960)
Comperia merceti (Compere, 1938)	A	parasitic/ predator	South America	1988, FR	F, IT	J	*Supella longipalpa*	Goudey-Perrière et al. (1988), Goudey-Perrière et al. (1991)
Comperiella bifasciata Howard, 1906	A	parasitic/ predator	Asia	1990, IT	BE, CY, CZ, ES, FR, GR, HU, IL, IT, IT-SIC, MD, NL, RU, UA	I, J100	*Aonidiella aurantii* & *A. citrina* on Citrus & passionfruit	Bénassy and Bianchi (1974), Liotta and Salvia (1991), Orphanides (1996)
Comperiella lemniscata Compere & Annecke, 1961	A	parasitic/ predator	Asia	1989, IT	ES, IL, IT	I	*Chrysomphalus dictyospermi*	Battaglia (1988), Garonna and Viggiani (1989), Pina et al. (2001)
Copidosoma floridanum (Ashmead, 1900)	A	parasitic/ predator	North America	1920, GB	BG, CZ, DE, ES, ES-CAN, FR, DE, GB, GR-CRE, HU, IT, NL, PT, RU, RS, SE, SK	I	Noctuid moths (Polyembryonic)	Guerrieri and Noyes (2005), Noyes (1988)
Copidosoma koehleri Blanchard, 1940	A	parasitic/ predator	C & S America	1994, IT	AL, CY, GR, IT	I	*Phtorimea operculella*	Guerrieri (1995), Guerrieri and Noyes (2005)
Diversinervus cervantesi (Girault,1933)	A	parasitic/ predator	Asia	1982, IL	IL	I	soft scale insects	Rosen and Alon (1983)
Diversinervus elegans Silvestri, 1915	A	parasitic/ predator	Africa	1977, IT	ES, FR, GR, IL, IT	I	black scale, *Saissetia oleae,* on olive, Citrus (polyphagous)	Kfir and Rosen (1980), Panis (1983), Viggiani and Mazzone (1977b)
Encyrtus fuscus (Howard, 1881)	A	parasitic/ predator	North America	1901, IT	IT	I, G3	*Lecanium* scales	Noyes and Hayat (1994)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Encyrtus infelix (Embleton, 1902)	A	parasitic/ predator	Africa	1901, GB	BE, DE, DK, ES, FR, GB, IL, NL	I, J100	Coccids (*Saissetia* spp.) on Citrus, Ficus	Embleton (1902)
Leptomastix dactylopii Howard, 1885	A	parasitic/ predator	Africa	1959, IT	AT, BA, BE, CY, CZ, DE, DK, ES, FI, FR, DE, GB, GR, IE, IL, IT, IT-SAR, IT-SIC, NL, NO, PL, PT, SE, YU	I, J100	Mealybugs (*Planococcus citri*) on many host plants (polyphagous)	Krambias and Kotzionis (1980), Longo and Benfatto (1982), Luppino (1979), Mineo and Viggiani (1976), Viggiani (1975b)
Metaphycus angustifrons Compere,1957	A	parasitic/ predator	Asia	1988, IL	IL	I2	Coccids on Nerium oleander, Asteraceae, *Cupressus* spp.., *Leonotis leoneurus*, *Olea* europaea, *Leucadendron pubescens*, Lycium tetrandrum	Trjapitzin (1989)
Metaphycus anneckei Guerrieri & Noyes, 2000	A	parasitic/ predator	Africa	1973	CY, ES, GR, IL, IT, PL, PT	I2	Coccids on *Nerium oleande*r, Asteraceae, *Cupressus* spp., *Leonotis leoneurus*, *Olea europaea, Leucadendron pubescens, Lycium tetrandrum*	Guerrieri and Noyes (2000)
Metaphycus flavus (Howard, 1881)	A	parasitic/ predator	North America	1915, FR	AL, CY, CZ, FR, ME, PT-MAD, PT, RU, ES-BAL	I	soft scales (Facultative gregarious parasitoid)	Monaco and D'Abbicco (1987), Noguera et al. (2003), Orphanides (1988), Tena-Barreda and Garcia-Mari (2006), Velimirovic (1994)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Metaphycus galbus Annecke, 1964	A	parasitic/ predator	Africa	1993, ES	ES	I	*Protopulvinaria pyriformis* on avocado	Guerrieri and Noyes (2000)
Metaphycus helvolus (Compere, 1926)	A	parasitic/ predator	Africa	1978, IT	AT, BE, CH, CY, DE, DK, ES, FR, FR-COR, GR, IL, IT, NL, SE	J100	Scale insects. Only in greenhouses	Argyriou and Katsoyannos (1976), Carrero (1980), Mazzone and Viggiani (1983), Montiel and Santaella (1995), Panis (1983), Panis et al. (1977), Stratopoulou and Kapatos (1984), Viggiani (1978)
Metaphycus inviscus Compere,1940	A	parasitic/ predator	Africa	1987, IT-SAR	ES, ES-BAL, IL	I2	Black scale, *Saissetia*	Argov and Rössler (1988), Guerrieri and Noyes (2000)
Metaphycus lounsburyi (Howard, 1898)	A	parasitic/ predator	Africa	1973, IT	CY, DK, ES, FR, IL, IT, IT-SIC, NL, PL	I2, J100	Black scale, *Saissetia oleae*, polyphagous on olive, citrus	Argyriou and Michelakis (1975), Canard and Laudeho (1977), Monaco (1976), Monaco and D'Abbicco (1987), Orphanides (1988), Panis (1977), Panis and Marro (1978), Tena-Barreda and Garcia-Mari (2006)
Metaphycus luteolus (Timberlake, 1916)	A	parasitic/ predator	North America	1989, IT	ES, IT, UA	I2	Fruit scales	Guerrieri and Noyes (2000), Viggiani and Guerrieri (1988)
Metaphycus maculipennis (Timberlake, 1916)	A	parasitic/ predator	North America	1988, IT	DE, ES, FR, GR, IT, RS		Coccidae on *Vitis*	Guerrieri and Noyes (2000)
Metaphycus orientalis (Compere, 1924)	A	parasitic/ predator	Asia	1989, BE	BE	I	Coccidae on *Citrus*	Guerrieri and Noyes (2000)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Metaphycus stanleyi Compere, 1940	A	parasitic/ predator	Africa	1960, IT	ES-CAN, ES, GR, IL, IT	I2	fruit scales	Argov and Rössler (1988), Blumberg et al. (1993), Guerrieri and Noyes (2000), Noyes and Hayat (1994), Trjapitzin (1989)
Metaphycus swirskii Annecke & Mynhardt, 1979	A	parasitic/ predator	Africa	1976, IT	ES , FR, GR, GR-CRE, IL, IT, NL	I2	scales on *Ficus, Citrus*, Coffee, *Solanum*	Annecke and Mynhardt (1979a), Panis (1981), Viggiani and Mazzone (1977b)
Microterys clauseni Compere,1926	A	parasitic/ predator	Asia	1987, IL	IL	I	*Ceroplastes floridensis* on *Citrus*	Argov and Rössler (1988)
Microterys nietneri (Motschulsky, 1859)	A	parasitic/ predator	Asia	1989, BG	BG, PT-AZO	I2	*Coccus*	Simoes et al. (2006)
Microterys speciosus Ishii,1923	A	parasitic/ predator	Asia	1987, IL	IL	I	*Ceroplastes floridensis* on Citrus	Argov and Rössler (1988)
Neodusmetia sangwani (Subba Rao,1957)	A	parasitic/ predator	Asia	1974, IL	IL	E	Rhodesgrass scale, *Antonina graminis*	Gerson et al. (1975)
Ooencyrtus kuwanae (Howard, 1910)	A	parasitic/ predator	Asia Temperate	1932, PT	AT, BA, BG, CH, CZ, DE, ES, FR, IT-SAR, MD, PL, PT, RO, RU, SK, UA, YU	G1	*Lymantria dispar*	Bjegovic (1962), Keremidchiev et al. (1980), Mihalache et al. (1995), Milanovic et al. (1998), Roversi et al. (1991)
Plagiomerus diaspidis Crawford, 1910	A	parasitic/ predator	North America	1994, IT-SIC	ES-CAN, FR, IT-SIC, PT-MAD	I	Diaspididae on *Opuntia*	Bue and Colazza (2005), Panis and Pinet (1999b), Russo and Siscaro (1994)
Prochiloneurus pulchellus Silvestri, 1915	A	parasitic/ predator	Africa	1972, IL	IL, IT	I	scale insects (polyphagous)	Trjapitzin (1989)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Pseudaphycus angelicus (Howard, 1898)	A	parasitic/ predator	Tropical, subtropical	1964, IL	IL, RU	I, J100	Pseudococcids (*Vitis*, *Solanum*)	Noyes and Hayat (1994), Walton and Pringle (2002)
Pseudaphycus malinus Gahan,1946	A	parasitic/ predator	Asia-Temperate	1998, IL	IL, RU	I, J100	Pseudococcids on *Citrus*	Blumberg et al. (1999a)
Pseudectroma signatum (Prinsloo,1982)	A	parasitic/ predator	Africa	1986, IL	IL	I2	*Nipaecoccus viridis* on *Citrus*	Bar-Zakay et al. (1987)
Psyllaephagus pilosus Noyes, 1988	A	parasitic/ predator	Australasia	2006, FR-COR	FR, FR-COR, GB, IE, IT	I2	*Ctenarytaina eucalypti* on *Eucalyptus*	Bennett (2005), Chauzat et al. (2002), Costanzi et al. (2003a), Costanzi et al. (2003b), Malausa and Girardet (1997), Schnee et al. (2006)
Rhopus nigroclavatus (Ashmead, 1902)	A	parasitic/ predator	North America	1978, ES	ES	I	scale insects on Poaceae	Trjapitzin (1989)
Tachinaephagus zealandicus Ashmead, 1904	A	parasitic/ predator	Australasia	2002, PT-MAD	DK, IT, PT-AZO, PT-MAD	J	*Musca domestica* in poultry houses	Japoshvili and Noyes (2006), Koponen and Askew (2002), Turchetto et al. (2003)
Tetracnemoidea brevicornis (Girault, 1915)	A	parasitic/ predator	Australasia	1987, IT	FR, IT	I, J100	citrus mealybug, Pseud*ococcus calceolariae*	Laudonia and Viggiani (1986a)
Tetranecmoidea peregrina (Compere, 1939)	A	parasitic/ predator	C & S America	1994, PT	ES, FR, IL, IT, PT	I, J100	citrus mealybug, *Pseudococcus calceolariae*	Trjapitzin (1989)
Tineophoctonus armatus (Ashmead, 1888)	A	parasitic/ predator	North America	1963, ES	ES, IT	J	Anobiidae	Trjapitzin (1989)
Zarhopalus sheldoni Ashmead, 1900	A	parasitic/ predator	North America	1945, RU	RU	J100	*Pseudococcus comstocki*	Noyes and Hayat (1994)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Eulophidae								
Aceratoneuromyia indica (Silvestri, 1910)	A	parasitic/ predator	Australasia	1974, IT	GB, IT	I, J100	fruit flies, *Anastrepha*	Graham (1991), Viggiani (1975a)
Aprostocetus ceroplastae (Girault, 1916)	A	parasitic/ predator	Africa	1962, IL	FR, GR, IL, IT	I	Coccidae (Ceroplastes) on fruit trees	Argyriou and Kourmadas (1980), Avidov et al. (1963), Domenichini et al. (1964)
Aprostocetus diplosidis Crawford, 1907	A	parasitic/ predator	North America	1964, IT	IT	E	*Contarinia sorghicola*	Priore and Viggiani (1965)
Aprostocetus microcosmus (Girault, 1917)	A	parasitic/ predator	North America	1977, ES-CAN	ES-CAN	I	Cecidomyiidae on Poaceae	Graham (1987)
Aprostocetus sicarius (Silvestri, 1915)	A	parasitic/ predator	Africa	1962, IL	IL, ME	I	*Bactrocera oleae*	Avidov et al. (1963), OILB (1971)
Astichus trifasciatipennis (Girault, 1913)	A	parasitic/ predator	Australasia	1989, IT	IT	G5	Gracillariidae on *Robinia pseudoacacia*	Serini (1990)
Ceranisus americensis (Girault, 1917)	A	parasitic/ predator	North America	1994, NL	NL	I	Thrips	Loomans et al. (1995)
Ceranisus russelli (Crawford, 1911)	A	parasitic/ predator	North America	1954, GB	GB	I	Thrips	Thompson (1955)
Chaenotetrastichus semiflavus (Girault, 1917)	A	parasitic/ predator	North America	1995, DE	DE	G	Pompilidae	Vidal (1996)
Chouioia cunea Yang, 1989	A	parasitic/ predator	Asia	1990, IT	IT	G1	*Hyphantria cunea*	Boriani (1991)
Chrysocharis ainsliei Crawford, 1912	A	parasitic/ predator	North America	1984, IT	DK, IT	I	*Phytomyza* on artichokes	Hansson (1985), Ikeda (1996)
Chrysocharis oscinidis Ashmead, 1888	A	parasitic/ predator	North America	1984, NL	FR, NL	I	*Liriomyza*	Fry (1989), Woets and Linden (1985)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Cirrospilus ingenuus Gahan,1932	A	parasitic/ predator	Asia	1994, IL	CY, ES, IL, PT-MAD, PT	I	*Phyllocnistis citrella* in *Citrus* orchards	Argov and Rössler (1996), Vercher et al. (2000)P
Citrostichus phyllocnistoides (Narayanan, 1960)	A	parasitic/ predator	Asia	1995, IL	ES-BAL, GR, IL, IT, IT-SIC, IT, PT	I	*Phyllocnistis citrella* in *Citrus* orchards	Argov and Rössler (1996), Barbagallo et al. (2000), Michelakis and Vacante (1997), Vercher et al. (2000)
Closterocerus cinctipennis Ashmead, 1888	A	parasitic/ predator	North America	1971, IT	IT	G5	*Parectopa robiniella* on *Robinia*	Vidano and Marletto (1972)
Diglyphus begini (Ashmead, 1904)	A	parasitic/ predator	North America	1988, CZ	CZ, NO	I	Leafminer parasitoid	Hagvar et al. (1994), Kalina (1989)
Edovum puttleri Grissell, 1981	A	parasitic/ predator	C & S America	1985, IT	IT, RU	I1	Colorado potato beetle	Laudonia and Viggiani (1986b), Yefremova (2002)
Elachertus cidariae (Ashmead, 1898)	A	parasitic/ predator	North America	1962, YU	YU	G1	fall webworm in deciduous trees	Tadic MD (1964)
Euderus cavasolae (Silvestri, 1914)	A	parasitic/ predator	Africa	1954, IT	IT	I	*Bactrocera oleae*	Thompson (1955)
Galeopsomyia fausta LaSalle, 1997	A	parasitic/ predator	C & S America	1999, ES	ES	I2	*Phyllocnistis citrella* on *Citrus*	Vercher et al. (2000)
Goetheana shakespearei Girault, 1920	A	parasitic/ predator	Australasia	1992, ES	ES	I	Thrips	Viggiani and Nieves Aldrey (1993)
Hyssopus thymus Girault, 1916	A	parasitic/ predator	North America	1970, DE	DE	G3, I2	*Rhyacionia buoliana* pine stands	Konig and Bogenschutz (1971)
Leptocybe invasa Fisher & LaSalle, 2004	A	phyto-phagous	Australasia	2003, PT	ES, FR, FR-COR, IL, IT, PT	G1	gall-former on *Eucalyptus*	Anagnou-Veroniki et al. (2008), Kim et al. (2008), Mendel et al. (2004), Protasov et al. (2008)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Ophelimus maskelli (Ashmead 1900)	A	phyto-phagous	Australasia	2000, IT	ES, FR, FR-COR, GR, IL, IT, PT	G1	gall-former on *Eucalyptus camaldulensis* (N), other *Eucalyptus* (I)	Branco et al. (2009), Protasov et al. (2007a), Protasov et al. (2007b), Rizzo et al. (2006), Sasso et al. (2008)
Pediobius phyllotretae (Riley, 1884)	A	parasitic/ predator	North America	1944, CZ	CZ, DE, GB	I	*Phyllotreta zimmermanni*	Boucek (1965)
Quadrastichodella nova Girault, 1922	A	phyto-phagous	Australasia	1968, IL	ES, FR-COR, IL, IT, IT-SAR, PT	G1	gall-former on *Eucalyptus*	Boucek (1977a), Rasplus (1992)
Semielacher petiolata (Girault, 1915)	A	parasitic/ predator	Australasia	1995, IL	CY, ES, ES-BAL, GR, IL, IT, IT-SIC, PT	I2	*Phyllocnistis citrella* on *Citrus*	Argov and Rössler (1996), Barbagallo et al. (2000), Michelakis and Vacante (1997), Siscaro et al. (1999)
Tetrastichomyia clisiocampae (Ashmead, 1894)	A	parasitic/ predator	North America	1966, IT	IT	G1, I	Lepidoptera	Domenichini (1967)
Thripobius javae (Girault, 1917)	A	parasitic/ predator	Asia	1995, IT	BE, DE, DK, FR, IL, IT, IT-SIC, NL	J100	Greenhouse thrips on *Citrus, Viburnumn, Vitis* and others	Viggiani and Bernardo (1996), Wysoki et al. (2000)
Eupelmidae								
Anastatus japonicus Ashmead, 1904	A	parasitic/ predator	Asia	1920, HU	CZ, HU, SK, YU	G1	*Lymantria* and forest moths	Ruschka (1921)
Anastatus tenuipes Bolivar & Pieltain, 1925	A	parasitic/ predator	Africa	1999, IT	IT	J	*Supella longipalpa* (Blattidae)	Russo et al. (2000)
Eupelmus afer Silvestri, 1914	A	parasitic/ predator	Africa	1974, IT	IT	I	*Bactrocera oleae*	Viggiani (1975a)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Eupelmus australiensis (Girault, 1913)	A	parasitic/ predator	Australasia	1964, IT	IT, SK, UA, YU	I, I1, F5	sorghum midge (Cecidomyiidae) and other midge on Poaceae	Boucek (1977b), Kalina (1989), Priore and Viggiani (1965), Trjapitzin (1978)
Eupelmus longicorpus Girault, 1915	A	parasitic/ predator	Australasia	1987, ES	ES	I	midge on Poaceae	Bouček (1988)
Eurytomidae								
Bruchophagus sophorae Crosby & Crosby, 1929	A	phyto-phagous	Asia	1960, RO	BG, HU, RO, RS, RU, SK, UA, YU	I2	*Sophora* seeds	Grubik (1992), Mihajlovic (1983), 3871996477
Eurytoma aloineae (Burks, 1958)	A	phyto-phagous	Africa	1957, DE	DE	J100	*Aloe*	Burks (1958)
Eurytoma orchidearum (Westwood, 1869)	A	phyto-phagous	North America	1962, FR	DK, FR, NL	J100	*Cattleya* and other orchids	Gijswijt (2003), Peck (1963)P
Prodecatoma cooki (Howard, 1896)	A	phyto-phagous	North America	1886, AT	AT	I	Grape wasp, *Vitis*	Howard (1896)
Tetramesa albomaculatum (Ashmead, 1894)	A	phyto-phagous	North America	1977, GB	BG, DE, GB, SE	I1	Wheat and Poaceae	Boucek and Graham (1978), Hedqvist (2003), Stojanova (2004), Vidal (2001)
Tetramesa maderae (Walker, 1849)	A	phyto-phagous	North America	1870, IT	ES, HU, IL, IT, RO, RU, UA	I1	wheat and Poaceae	Popescu (2004), Porchinsky (1881), Walker (1871)
Tetramesa swezeyi (Phillips & Poos, 1922)	A	phyto-phagous	Unknown	1977, RU	RU, UA	I1	wheat and Poaceae	Zerova (1978)
Figitidae								
Aganaspis daci (Weld, 1951)	A	parasitic/ predator	Africa	1970, FR	FR, GR_NEG	I	*Bactrocera oleae*	Nunez-Bueno (1982), Papadopoulos and Katsoyannos (2003)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Formicidae								
Brachymyrmex heeri Forel, 1874	A	parasitic/ predator	C & S America	1874, CH	CH, DE, FR, UA	J100	Greenhouses	Forel (1874)
Cardiocondyla emeryi Forel, 1881	A	parasitic/ predator	Africa	1894, PT	ES-CAN, PT-MAD	G, I2, J1, X24	Natural sites and gardens, arid sites	Heinze and Trenkle (1997), Kluger (1983), Reyes-Lopez et al. (2008), Wetterer et al. (2007)
Cardiocondyla mauritanica Forel, 1890	A	parasitic/ predator	Africa	1981, ES-CAN	CY, ES, ES-CAN, IL, IT, IT-SAR, IT-SIC PT-MAD	I2, X24, J1	Gardens, houses, buildings	Finzi (1936), Mei (1995), Wetterer et al. (2007)
Cardiocondyla obscurior (Wheeler, 1929)	A	parasitic/ predator	Africa	1930, IL	ES-CAN, IL	I2	Miscelleanous habitats, disturbed areas, beaches	Seifert (2003)
Cardiocondyla wroughtoni (Forel, 1890)	A	parasitic/ predator	Asia	1982, IL	IL	H5, J	Miscelleanous habitats, disturbed areas	Kluger (1983)
Crematogaster brevispinosa Mayr, 1870	A	parasitic/ predator	C & S America	1935, CZ	CZ	J100	Greenhouses	Šefrová and Laštůvka (2005)
Hypoponera ergatandria (Forel, 1893)	A	parasitic/ predator	C & S America	1952, DE	DE, FR	J	Sparse or no vegetation, buildings	Geiter et al. (2002)
Hypoponera punctatissima (Roger, 1859)	A	parasitic/ predator	Tropical, subtropical	1847, PT	AT, BE, BG, CH, CZ, DE, DK, ES, ES-CAN, FR, FR-COR, GB, GR, HU, IE, IS, IT, LU, MT, NL, NO, PT, PT-AZO, PT-MAD, RO, RS, RU, SE, SK, UA, YU	J, J100, I2, X24	Antropophilic, in greenhouses or other heated biuldings, gardens in Madeira	Blacker (2007), Boer et al. (2003), Boer et al. (2006), Carniel and Governatori (1994), Czechowska and Czechowski (1999b), Dessart and Cammaerts (1995), Jones (1997), Seifert (1982), Wetterer et al. (2007)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Lasius neglectus Van Loon, Boomsma & Andrasfalvy, 1990	A	parasitic/ predator	Asia-Temperate	1973, HU	BE, BG, CZ, DE, ES, FR, GL, HU, PL, PT	I2, X24	Polygynous species, parks and gardens	Boomsma et al. (1990), Czechowska and Czechowski (1999a), Czechowska and Czechowski (2003), Dekoninck et al. (2002), Espadaler (1999), Markó (1988), Neumeyer (2008), Schultz and Busch (2009), Seifert (1992), Seifert (2000), Van Loon et al. (1990)
Lasius turcicus Sanctchi, 1921	A	parasitic/ predator	Asia-Temperate	1970, HU	AL, BE, BG, CZ, DE, DK, EE, ES, ES-CAN, FR, GR, HU, IT, PL, RO	I2, X24	Gardens	Seifert (1996)
Linepithema humile (Mayer, 1868)	A	parasitic/ predator	C & S America	1847, PT	BE, BG, CH, CZ, DE, ES, ES-CAN, FR, FR-COR, GB, IT, IT-SAR, IT-SIC, PL, PT, PT-AZO, PT-MAD	J, G, I2	Various habitats indoors and outdoors	Giraud et al. (2002), Suarez et al. (2001), Wild (2004), Wild (2009)
Linepithema leucomelas Emery, 1894	A	parasitic/ predator	C & S America	1955, AT	AT	J100	Gardens, greenhouses	Wild (2007)
Monomorium andrei Saunders, 1890	A	parasitic/ predator	Africa	1924, ES	ES, ES-BAL	J	Urban environment	Reyes Lopez and Luqque Garcia (2003)
Monomorium destructor (Jerdon, 1851)	A	parasitic/ predator	Asia	1892, ES-BAL	ES-BAL, PL, PT	J1	Urban environment	Boer and Vierbergen (2008), Salgueiro (2003), Šefrová and Laštůvka (2005), Wetterer (2009a), Yarrow (1967)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Monomorium floricola (Jerdon, 1851)	A	parasitic/ predator	Asia-Tropical	1982, DE	DE	J100	Greenhouses	Sellenschlo (1991)
Monomorium pharaonis (Linnaeus, 1758)	A	parasitic/ predator	tropical	1892, ES	AT, BG, CH, CZ, DE, DK, EE, ES-CAN, FR, FR-COR, GB, HU, IL, IT, IT-SAR, IT-SIC, LT, ME, NL, NO, PT-MAD, PT, RS	J1, J100, X25, I2	Stored products antropophilic, mainly indoors, gardens in Madeira	Markó et al. (2006), Salgueiro (2003)
Monomorium salomonis (Linnaeus, 1758)	A	parasitic/ predator	tropical	1881, FRL	ES, ES-BAL, FR, GB, IT, IT-SAR, IT-SIC, MT	F6, J100	Garrigue	Salgueiro (2003)
Pachycondyla darwinii Forel, 1893	A	parasitic/ predator	Unknown	Unknown, MT	MT	U	Forested areas	
Paratrechina bourbonica (Forel, 1886)	A	parasitic/ predator	Tropical, subtropical	Unknown, GB	GB	U	Cosmopolitan, tropics	Fitton et al. (1978)
Paratrechina flavipes (Smith, 1874)	A	parasitic/ predator	Asia-Tropical	1952, DE	DE, ES	J1	Buildings	Espadaler and Colllingwood (2000)
Paratrechina jaegerskioeldi (Mayr, 1904)	A	parasitic/ predator	Africa	1989, ES-MAD	ES, ES-CAN, GR-CRE, PT-MAD	J2, I2, X24	Low constructed buildings, gardens	Collingwood (1993), Espadaler and Bernal (2003), Kluger (1988)
Paratrechina longicornis (Latreille, 1802)	A	parasitic/ predator	Africa	1847, ES-MAD	CH, CZ, DE, ES, ES-CAN, FI, FR, GB, IL, IT, MT, PT-AZO, PT-MAD	H, I2, J1, J100	Houses, buildings, plant cavities, trees, debris, rotten wood	Collingwood et al. (1997), Espadaler and Bernal (2003) , Freitag et al. (2000), Heinze (1986), Tinaut and Año (2000)
Paratrechina vividula (Nylander, 1846)	C	parasitic/ predator	Crypto-genic	1881, FI	CY, CZ, DE, FI, FR, GB, GR, NL, RU, SE, UA	J, J100	Constructed areas, greenhouses	Collingwood and Hughes (1987)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Pheidole bilimeki Mayr 1870	A	parasitic/ predator	C & S America	1952, DE	CH, DE, DK, FR, GB	J100	Greenhouse	Longino and Cox (2009)
Pheidole guineensis (Fabricius, 1793)	A	parasitic/ predator	Tropical, subtropical	1883, FR	FR, DE	J100	Sparsely wooded area (N), greenhouse(I)	
Pheidole megacephala (Fabricius, 1793)	A	parasitic/ predator	Africa	1847, PT-MAD	DE, ES, ES-CAN, FR, GB, GR, GR-CRE, IT, ME, PT, PT-AZO, PT-MAD, RO, YU	I2, J1, J100	Gardens, urban	Bernard (1968), Limonta and Colombo (2003)
Pheidole noda (Smith, 1874)	A	parasitic/ predator	Asia	2003, IT	IT	I2	Nursery	Limonta and Colombo (2003)
Pheidole teneriffana Forel, 1893	A	parasitic/ predator	Africa	1893, ES-BAL	ES, ES-BAL, ES-CAN, GR, GR-CRE, GR_SEG, GR, IT-SIC	I2, X24	Disturbed areas	De Haro et al. (1986), Gomez and Espadaler (2006)
Plagiolepis alluaudi (Emery, 1894)	A	parasitic/ predator	Asia-Temperate	1915, IE	CH, DE, FR, IE	J100	Greenhouses	Geiter et al. (2002)
Plagiolepis exigua Forel, 1894	A	parasitic/ predator	Tropical, subtropical	1952, DE	DE	J100	Greenhouses	Geiter et al. (2002)
Plagiolepis obscuriscapa Santschi, 1923	A	parasitic/ predator	C & S America	Unknown	IT, RO	U	Unknown	Moscaliuc (2009)
Pyramica membranifera (Emery, 1869)	A	parasitic/ predator	Africa	1989, PT-MAD	PT-MAD	I2, X24	Gardens	Espadaler (1979), Espadaler and Lopez Soria (1991)
Strumigenys lewisi Cameron, 1886	A	parasitic/ predator	Asia	1996, MT	MT	J100	Greenhouses	Schembri and Collingwood (1995)
Strumigenys rogeri Emery, 1890	A	parasitic/ predator	Africa	Unknown	DE, GB	J100	Greenhouses	

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Strumigenys silvestrii Emery, 1906	A	parasitic/ predator	North America	1989, PT-MAD	PT-MAD	I2, X24	Gardens; predator on collembola	Geiter et al. (2002)
Tapinoma melanocephalum (Fabricius, 1793)	A	parasitic/ predator	Tropical, subtropical	1984, DE	AT, CH, DE, FI, GB, RU	J1, J100	stored products, antropophilic, indoors only	Boer and Vierbergen (2008), Espadaler and Espejo (2002), Hogmo (2003b), Jucker et al. (2008), Scheurer and Liebig (1998), Sorvari (2002), Vipin et al. (1999), Wetterer (2009b)
Technomyrmex albipes (Smith, 1861)	A	detrivorous	Asia-Tropical	1989, PT-MAD	AT, NL, PT-MAD	I2, X24, J1	Gardens, houses	Boer and Vierbergen (2008)
Technomyrmex detorquens (Walker, 1859)	A	parasitic/ predator	Asia	1937, CZ	AT, CZ, DE	J100	Greenhouses, houses	Šefrová and Laštůvka (2005)
Temnothorax longispinosus Roger, 1863	A	parasitic/ predator	North America	Unknown, ES	ES	D6	Oak and mixed woodland	
Tetramorium bicarinatum (Nylander, 1846)	A	parasitic/ predator	Asia-Tropical	2003, IT	DE, IT, PT-AZO, SE	J100	Nurseries	Högmo (2003a), Reyes and Espadaler (2005), Wetterer et al. (2004)
Tetramorium insolens (Smith, 1861)	A	parasitic/ predator	Asia, ATstralasia	Unknown	AT, FR, NL, PL	J100	Greenhouses	de Jonge (1985), Radchenko et al. (1998), Radchenko et al. (1999)
Tetramorium lanuginosum Mayr, 1870	A	parasitic/ predator	Asia	Unknown	IL, MT	J100	Greenhouses s	Reyes and Espadaler (2005), Schembri and Collingwood (1995)
Tetramorium simillimum (Smith, 1851)	A	parasitic/ predator	Tropical, subtropical	Unknown	DE, EE, FR, GB, IL, PL, PT-AZO, PT-MAD, GB	J100	Greenhouses	Bernard (1968), Wetterer et al. (2006)

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Ichneumonidae								
Auberteterus alternecoloratus (Cushman, 1929)	A	parasitic/ predator	Asia-Temperate	Unknown	FR, R	I	Stem borers (Pyralidae)	Gokhman (1996)
Cryptus luctuosus Cresson, 1864	A	parasitic/ predator	North America	Unknown	AT, FR, RU	G3	Sawflies on *Tsuga*	
Cteniscus dorsalis Cresson, 1864	A	parasitic/ predator	North America	Unknown	FR, NO	G3	Sawflies	
Delomerista novita (Cresson, 1870)	A	parasitic/ predator	North America	Unknown	AT, DE, FI, GB, NL, NO, PL, RU	G3	Sawflies (Diprionidae and others)	Hedstrom (1987), Jussila (1989), Phillips (1997)
Ephialtes spatulatus (Townes, 1960)	A	parasitic/ predator	North America	Unknown	AT, PL, RU, SE	G3	Xylophagous beetles	Hedstrom (1987)
Itoplectis conquisitor (Say,1835)	A	parasitic/ predator	North America	Unknown, DE	DE	I	Apple tortricid	Biermann (1973)
Megachilidae								
Osmia cornifrons (Radoszkowski, 1887)	A	phyto-phagous	Asia-Temperate	1970, DK	DK	I, E	Pollinator of fruit trees	Kristjansson and Rasmussen (1990)
Mymaridae								
Anaphes nitens (Girault, 1928)	A	parasitic/ predator	Australasia	1977, IT	ES, FR, IT, PT	I2	*Eucalyptus* snout-beetle *Gonipterus scutellatus* (egg Parasitoid)	Arzone and Vidano (1978), Cadahia (1986), Rivera et al. (1999), Vaz et al. (2000)
Polynema striaticorne Girault, 1911	A	parasitic/ predator	North America	1966, IT	IT	I2	*Ceresa bubalus*	Vidano (1968)
Pamphiliidae								
Cephalcia alashanica (Gussakovskij, 1935)	A	phyto-phagous	Asia-Temperate	1986, NL	NL	G3	*Picea*	Battisti and Sun (1996), Gossner et al. (2007), Holusa et al. (2007), Jachym (2007), Shinohara and Zombori (2003)

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Perilampidae								
Steffanolampus salicetum (Steffan, 1952)	A	parasitic/ predator	North America	1876, AT	AT	G	*Ptilinus* (Anobiidae)	Giraud and Laboulbène (1878)
Platygastridae								
Amitus fuscipennis MacGown & Nebeker, 1978	A	parasitic/ predator	North America	1980, IT	IT	J100	*Trialeurodes vaporariorum*	Manzano et al. (2002), Viggiani (1997), Vis and Lenteren (2008)
Amitus spiniferus (Brèthes, 1914)	A	parasitic/ predator	Tropical, subtropical	1971, FR	ES, FR, IT, IT-SIC	J100	*Aleurothrixus floccosus*	DeBach and Rose (1976a), Liotta et al. (2003)
Pteromalidae								
Anisopteromalus calandrae (Howard, 1881)	C	parasitic/ predator	Cryptogenic	1911, AT	AT, BE, CH, CZ, DE, FR, GB, GR, HU, IL, IT, PT, RO, RU, RS, SE, SK	J	Stored products beetles	Beratlief (1967), Boucek (1977b), Boucek and Graham (1978), Frilli (1965), Garrido-Torres and Nieves-Aldrey (1990), Hedqvist (2003), Kalina (1989), Mitroiu (2001), Ruschka (1912)
Halticoptera daci Silvestri, 1914	A	parasitic/ predator	Africa	1957, IT	IT	I	*Bactrocera oleae*	Thompson (1958)
Mesopolobus modestus (Silvestri, 1914)	A	parasitic/ predator	Africa	1974, IT	IT	I	*Bactrocera oleae*	Viggiani (1975a)
Mesopolobus pinus Hussey, 1960	A	parasitic/ predator	North America	1953, GB	BE, DK, FR, GB, NL, PL, SE	G3	*Megastigmus* seed chalcid in Abies seeds	Bak (1999), Pettersen (1976), Skrzypczynska (1989), Wisniowski (1987)
Mesopolobus spermotrophus Husey, 1960	A	parasitic/ predator	North America	1952, GB	BE, CZ, DE, FR, GB, IT, LU, NL, PL, SE	G3	*Megastigmus* seed chalcid in Douglas-fir seeds	Graham (1969)

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Monoksa dorsiplana Boucek, 1991	A	parasitic/ predator	C & S America	1980, IL	IL	U	Seed-beetles	Boucek (1991)
Moranila californica (Howard, 1881)	A	parasitic/ predator	Australasia	1973, IT	ES, ES-CAN, FR, GR, IL, IT, IT-SIC, IT	G, I2, F	Scales, *Quercus, Citrus, Fagus, Olea (*Highly polyphagous)	Raspi (1988), Simoes et al. (2006), Stratopoulou et al. (1981)
Muscidifurax raptor Girault & Sanders, 1910	A	parasitic/ predator	North America	1954, CZ	CZ, DE, DK, ES, IT, RO	J	*Musca domestica* and stable files	Fabritius (1978), Fabritius (1981), Rutz and Axtell (1979)
Paracarotomus cephalotes Ashmead, 1894	A	parasitic/ predator	North America	1976, FR	FR, IT, RU,			Boucek (1976), Dzhanokmen (1984)
Spalangia cameroni, Perkins 1910	A	parasitic/ predator	North America	1969, DK	CY, CZ, DE, DK, ES, IT, MD, RO, SE	J	*Musca domestica* and stable files	Falco et al. (2006), Gibson (2009), Maini and Bellini (1991), Tormos et al. (2009)
Theocolax elegans (Westwood, 1874)	C	parasitic/ predator	Crypto-genic	1957, DE	BE, DE, GR,	J	Stored products beetles	Eliopoulos et al. (2002), Mitroiu (2001), Thompson (1958)
Urolepis rufipes (Ashmead, 1896)	A	parasitic/ predator	North America	1989, DE	DE, DK, SE	J	house flies (pupae)	Gibson (2000), Hedqvist (2003), Skovgard and Jespersen (1999)
Scelionidae								
Duta tenuicornis (Dodd, 1920)	A	parasitic/ predator	Australasia	1989, HU	HU, MD	I	Crickets (Egg parasitoid)	Popovici (2005)
Gryon leptocorisae (Howard, 1885)	A	parasitic/ predator	North America	Unknown	DK, FR, IT	I	*Stenocoris* (Egg parasitoid)	Mineo (1981)
Telenomus busseolae Gahan, 1922	A	parasitic/ predator	Africa	Unknown, IT	IT	I	Stem borers (Egg parasitoid)	Conti and Bin (2000), Gullu and Simsek (1995), Laudonia et al. (1991)

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Signiphoridae								
Chartocerus niger (Ashmead, 1900)	A	parasitic/ predator	North America	Unknown	ES, FR, IT	U	Scale insects (Hyperparasitoid via Encyrtids)	Woolley (1988)
Siricidae								
Sirex areolatus (Cresson, 1867)	A	phyto-phagous	North America	1995, GB	GB, IT	G3	Conifers	Viitasaari and Midtgaard (1989)
Sirex cyaneus cyaneus Fabricius, 1781	A	phyto-phagous	North America	1885, FR	BE, CH, DE, DK, FR, GB, GR, HU, IE, IL, IT, LU, NL, PT, SE, SK	G3, I2	Conifer trunks (mainly *Abies*)	Hayes (1982), Hellrigl (1984), Kirk (1974), Midtgaard (1986), Schwarz (1994), Viitasaari and Midtgaard (1989)
Tremex columba (Linnaeus, 1763)	A	phyto-phagous	North America	1957, GB	GB	G, I2	*Fagus, Quercus, Acer, Betula*, etc	Winter (1988)
Urocerus albicornis (Fabricius, 1781)	A	phyto-phagous	North America	1991, GB	GB, IS, NL, PL	G3	Conifers	Witmond (2001)
Urocerus californicus Norton, 1869	A	phyto-phagous	North America	1944, GB	GB	G3	Conifers	Fitton et al. (1978)
Sphecidae								
Isodontia mexicana (Saussure, 1867)	A	parasitic/ predator	North America	1960, FR	AT, CH, DE, ES, FR, FR-COR, HR, IT, SI	E, X25	Crickets in grasslands (predatory)	Pagliano et al. (2000), Scaramozzino and Pagliano (1987)
Sceliphron cementarium (Drury, 1773)	A	parasitic/ predator	North America	1945, FR	AT, BE, DE, ES-CAN, FR, FR-COR, HR, IT, LU, PT-MAD, PT, UA	C3, X25	Adults nectar at flowers and mud nests are built in sheltered locations such as garages and underneath bridges	Bitsch et al. (1997), Pagliano et al. (2000)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Sceliphron curvatum (Smith, 1870)	A	parasitic/ predator	Asia-Temperate	1979, AT	AT, BG, CH, ,CZ, DE, FR, FR-COR, HR, HU, IT, IT-SAR, IT-SIC,RS, SI, UA,	C3, X25	Adults nectar at flowers and mud nests are built in Sheltered locations such as garages and underneath bridges, predatory	Bitsch and Barbier (2006), Bogusch et al. (2005), Castro (2007), Cetkovic et al. (2004), Ebmer (1995), Gonseth et al. (2001), Rahola (2005), van der Vecht (1984)
Sceliphron deforme (Smith, 1856)	A	parasitic/ predator	Asia-Temperate	1998, ME	FR, ME	C3, X25	Adults nectar at flowers and mud nests are built in sheltered locations such as garages and underneath bridges, predatory	Cetkovic et al. (2004)
Tenthredinidae								
Nematus (*Pteronidea*) *tibialis* Newman, 1837	A	phyto-phagous	North America	1825, DE	AT, BE, BG, CH, CZ, DE, ES, FI, FR, GB, GR, HR, HU, IT, LT, MD, NL, PL, RO, SK, UA	G, I2	*Robinia*	Ermolenko and Sem'yanov (1981), Markó et al. (2006)
Pachynematus (*Larinematus*) *itoi* Okutani, 1955	A	phyto-phagous	Asia-Temperate	1971, AT	AT	G3, G5	*Larix*	Pschorn-Walcher and Zinnert (1971)
Torymidae								
Eridontomerus isosomatis (Riley, 1882)	A	parasitic/ predator	North America	1912, HU	CZ, HU, SK, UA	I	*Tetramesa* on Poaceae	Boucek (1968), Erdös (1954), Grissell (1995)
Megastigmus aculeatus nigroflavus Hoffmeyer, 1929	A	phyto-phagous	North America	1966, DE	BG, DE, FR, RU	F, I2, E5	*Rosa*	Roques and Skrzypczynska (2003)

Families *Species*	**Status**	**Regime**	**Native range**	**First Record in Europe**	**Invaded countries**	**Habitat**	**Host**	**References**
Megastigmus atedius Walker, 1851	A	phyto-phagous	North America	1954, DE	CZ, DE, DK, FR, GB, PL, RU	G3, G4, X11	*Picea, Pinus strobus*	Jensen and Ochsner (1999), Roques and Skrzypczynska (2003)
Megastigmus borriesi Crosby, 1913	A	phyto-phagous	Asia-Temperate	1969, FIN-ALA	DK, FI-ALA, RU	X11	*Abies*	Annila (1970), Jensen and Ochsner (1999), Ochsner (1998)
Megastigmus lasiocarpae Crosby, 1913	A	phyto-phagous	North America	1969, FIN-ALA	FIN-ALA		*Abies*	Annila (1970)
Megastigmus milleri Milliron, 1949	A	phyto-phagous	North America	1952, GB	DK, FR, NL, GB	G3, G4, X11	*Abies*	Jensen and Ochsner (1999), Roques and Skrzypczynska (2003)
Megastigmus nigrovariegatus Ashmead, 1890	A	phyto-phagous	North America	1987, FR	FR	E5	*Rosa*	Roques and Skrzypczynska (2003)
Megastigmus pinsapinis Hoffmeyer, 1931	A	phyto-phagous	Africa	1858, FR	ES, FR, IT	G3, G4, X11	*Cedrus*	Pintureau et al. (1991), Roques and Skrzypczynska (2003), Skrzypczynska and Mazurkiewicz (2002)
Megastigmus pinus Parfitt, 1857	A	phyto-phagous	North America	1931, GB	BE, CZ, DE, DK, FR, GB, IE, NL, SE	G3, G4, X11	*Abies*	Jensen and Ochsner (1999), Roques and Skrzypczynska (2003)
Megastigmus rafni Hoffmeyer, 1929	A	phyto-phagous	North America	1930, GB	BE, DE, DK, FR, GB, NL	G3, G4, X11	*Abies*	Jensen and Ochsner (1999), Roques and Skrzypczynska (2003)
Megastigmus schimitscheki Novitzky, 1954	A	phyto-phagous	Asia-Temperate	1990, FR	FR	G3, G4	*Cedrus*	Roques and Skrzypczynska (2003)
Megastigmus specularis Walley, 1932	A	phyto-phagous	North America	1920, FIN-ALA	DK, FI, FR, RU, SE	G3, G4, X11	*Abies*	Jensen and Ochsner (1999), Roques and Skrzypczynska (2003)

Families *Species*	Status	Regime	Native range	First Record in Europe	Invaded countries	Habitat	Host	References
Megastigmus spermotrophus Wachtl, 1893	A	phyto-phagous	North America	1896, GB	AT, BE, CH, CZ, DE, DK, EE, ES, FI, FR, GB, HU, IE, IT, ME, NL, NO, PL, PT, RO, RS, RU, SE, SK, UA	G3, G4, X11	*Pseudotsuga*	Mailleux et al. (2008), Roques and Skrzypczynska (2003)
Megastigmus transvaalensis (Hussey, 1956)	A	phyto-phagous	Africa	1962, ES-CAN	ES, ES-CAN, FR, PT	I2, G5	*Schinus*	Grissell and Prinsloo (2001), Scheffer and Grissell (2003)
Trichogrammatidae								
Megaphragma mymaripenne Timberlake, 1924	A	parasitic/ predator	Asia-Tropical	1995, IT	IT-SIC, IT	I	Thrips (Egg parasitoid)	Sinacori et al. (1999), Viggiani and Bernardo (1996)
Oligosita distincta (Silvestri, 1915)	A	parasitic/ predator	Africa	1939, FR	FR, SE	I	Leafhoppers (Egg parasitoid)	Hedqvist (2003), Nowicki (1940)
Oligosita sanguinea (Girault, 1911)	A	parasitic/ predator	North America	1949, HU	HU	I	Cicadellid in wheat (Egg parasitoid)	Erdös (1956)
Trichogramma achaeae Nagaraja & Nagarkatti, 1970	A	parasitic/ predator	Asia	1987, FR	FR	I	Stem-borer (Egg parasitoid)	Voegelé et al. (1988)
Trichogramma chilonis Ishii, 1941	A	parasitic/ predator	Asia	1985, DE	DE, RO	I1	Cabbage moths, cotton bollworm, maize pyralid, armyworm	Glas and Hassan (1985)
Trichogramma dendrolimi Matsumura, 1926	A	parasitic/ predator	Asia	1978, BG	AT, BE, BY, BG, DE, FR, GR, HU, IT, LT, LV, MD, RO, RU, UA	I, G	Lepidoptera, e.g. *Epichoristodes acerbella*	Babi et al. (1984), Wetzel Dickler (1994)

Families *Species*	**Status**	**Regime**	**Native range**	**First Record in Europe**	**Invaded countries**	**Habitat**	**Host**	**References**
Trichogramma minutum Riley, 1871	C	parasitic/ predator	Crypto-genic	1957, CZ	CZ, DE, ES, FR, GB, GR, IT	I1, G	Maize borer and forest moths	CIBC (1976), Herting (1975), Thompson (1958), Viggiani and Laudonia (1989)
Trichogramma perkinsi Girault, 1912	A	parasitic/ predator	Asia	1984, FR	FR	I1	Lepidopteran pests (highly polyphagous)	Voegelé et al. (1988)
Trichogramma pretiosum Riley, 1879	C	parasitic/ predator	Crypto-genic	1975, GR	ES, GR, YU	I1	Cotton leafworm	Danon (1989), Stavraki (1976)
Uscana johnstoni (Waterston, 1926)	A	parasitic/ predator	Africa	1970, RO	RO	J	Bruchinae	Botoc (1971)
Uscana semifumipennis Girault, 1911	A	parasitic/ predator	North America	1963, HU	HU	J	Bruchinae	Reichart (1964)
Vespidae								
Vespa velutina nigrithorax du Buysson, 1905	A	parasitic/ predator	Asia-Temperate	2004, FR	FR	G	Woodland	Haxaire et al. (2006), Villemant et al. (2006)

Table 12.2. Hymenoptera species alien *in* Europe. List and characteristics. Country codes abbreviations refer to ISO 3166 (see appendix I). Habitat abbreviations refer to EUNIS (see appendix II). Last update 01/03/2010.

Families *Species*	**Status**	**Regime**	**Native range**	**First Record**	**Invaded countries**	**Habitat**	**Host**	**References**
Aphelinidae								
Eretmocerus mundus Mercet, 1931	E	parasitic/ predator	Medi-terranean region	Unknown	DE, NL	J100	Cotton whitefly, *Bemisia*, *Trialeurodes*	Drost et al. (1996)
Apidae								
Apis mellifera carnica (Pollmann, 1879)	E	phyto-phagous	Europe	2001, DK	DK, PT	I	Pollinator of various cultivated plants	Pedersen (1996)
Apis mellifera ligustica (Spinola, 1806)	E	phyto-phagous	Europe	1987, DK	DK, PT	I	Pollinator of various cultivated plants	Pedersen (1996)
Apis mellifera mellifera Linnaeus, 1758	E	phyto-phagous	Europe	2005, AL	AL, GL	I	Pollinator of various cultivated plants	
Bombus hortorum (Linnaeus, 1761)	E	phyto-phagous	Europe	1959, IS	IS	I	Pollinator of various cultivated plants	Prys-Jones et al. (1981)
Bombus lucorum (Linnaeus, 1761)	E	phyto-phagous	Europe	1979, IS	IS	I	Pollinator of various cultivated plants	Prys-Jones et al. (1981)
Argidae								
Arge berberidis Schrank, 1802	E	phyto-phagous	Europe	2000, GB	GB	I2	*Berberis*	Fitton et al. (1978)
Bethylidae								
Sclerodermus domesticus Klug, 1809	E	parasitic/ predator	Europe	2005 PT-AZO	PT-AZO, GB	J	Insects in wood furnitures; cause dermatitis in human by stings	Fitton et al. (1978)
Blasticotomidae								
Blasticotoma filiceti Klug 1834	E	phyto-phagous	Europe	1905, GB		I2, D2	*Athyrium* ferns (Leaf miner)	Schedl (1974)

Families *Species*	Status	Regime	Native range	First Record	Invaded countries	Habitat	Host	References
Chrysididae								
Chrysis marginata Mocsary, 1889	E	parasitic/ predator	Asia-Temperate	1915, HU	AT, HR, HU, IT	F6	Bees	Pagliano et al. (2000)
Cynipidae								
Andricus corruptrix (Schlechtendal, 1870)	E	phyto-phagous	Europe	1735, GB	GB, IE	G	*Quercus*	Fitton et al. (1978)
Andricus grossulariae Giraud,1859	E	phyto-phagous	Europe	Unknown, GB	GB	G,I2	*Quercus*	Fitton et al. (1978)
Andricus kollari (Hartig 1843)	E	phyto-phagous	Europe	1735, GB	GB	G	*Quercus*	Fitton et al. (1978)
Andricus lignicola (Hartig,1840)	E	phyto-phagous	Europe	1735, GB	GB	I2	*Quercus*	Fitton et al. (1978)
Andricus quercuscalicis (Burgesdorff 1783)	E	phyto-phagous	Europe	Unknown	GB, IE	I2	*Quercus*	Fitton et al. (1978)
Aphelonyx cerricola (Giraud 1859)	E	phyto-phagous	Europe	1993, GB	GB	G	*Quercus*	Fitton et al. (1978)
Diprionidae								
Diprion pini (Linnaeus, 1758)	E	phyto-phagous	Europe	Unknown, IE	IE	G3	*Pinus*	Fitton et al. (1978)
Diprion similis (Hartig, 1836)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	*Pinus*	Fitton et al. (1978)
Gilpinia hercyniae (Hartig, 1837)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	*Picea*	Fitton et al. (1978)
Gilpinia virens (Klug, 1812)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	*Pinus*	Fitton et al. (1978)
Neodiprion sertifer (Geoffroy, 1785)	E	phyto-phagous	Europe	Unknown	IE, GB	G3	*Pinus*	Fitton et al. (1978)

Families *Species*	Status	Regime	Native range	First Record	Invaded countries	Habitat	Host	References
Encyrtidae								
Ageniaspis fuscicollis (Dalman, 1920)	E	parasitic/ predator	Medi-terranean region	1735, GB	AU, BE, BY, CH, CZ, DE, DK, EE, ES-CAN, FI, GB, HU, IS, IE, LT, LV, LU, MD, NL, NO, NO-SVA, PL, PT-AZO, PT-MAD, RO, RU, SE, SK, UA	I	*Prays oleae* on *Citrus* and yponomeutids	Koscielska (1963), Kuhlmann (1994), Nénon (1978)
Anagyrus pseudococci (Girault, 1915)	E	parasitic/ predator	Medi-terranean region	1994, PT	CZ, ES-CAN, FR, HR, IL, MD, ME, NL, PT, RU, SE, YU	J100	Pseudococcids on *Citrus* and many crops	Tingle and Copland (1988)
Eulophidae								
Thripastichus gentilei (Del Guercio, 1931)	E	parasitic/ predator	Europe	1930, IT	DE, FR, IT, YU	I	Thrips	Del Guercio (1931), Domenichini et al. (1964), Herting (1971)
Eurytomidae								
Bruchophagus robiniae Zerova, 1970	E	parasitic/ predator	Europe	1969, UA	BG, UA,	G5	Seed feeder on *Robinia pseudoacacia*	Stojanova (1997), Zerova (1970)
Formicidae								
Aphaenogaster senilis Mayr, 1853	E	parasitic/ predator	Medi-terranean region	2005, PT-AZO	PT-AZO,	U	Natural habitat, garrigue	Wetterer et al. (2004)
Crematogaster scutellaris (Olivier, 1792)	E	parasitic/ predator	Europe	Unknown	DE, GB	J	Trees	Bernard (1968)
Lasius alienus (Foerster, 1850)	E	parasitic/ predator	Europe	Unknown, IE	IE	E1, H5	Warm, dry, stony environnements	Collingwood (1958)
Lasius flavus (Fabricius, 1781)	E	parasitic/ predator	Europe	Unknown, IE	IE	E1, E5	Meadows, dry grasslands, Forest borders	Collingwood (1958)

Families *Species*	Status	Regime	Native range	First Record	Invaded countries	Habitat	Host	References
Lasius fuliginosus (Latreille, 1798)	E	parasitic/ predator	Europe	Unknown, IE	IE	E5	Trunks and stumps, forest borders	Edwards (1997)
Ponera coarctata (Latreille, 1802)	E	parasitic/ predator	Medi-terranean region	Unknown	BE, BG, DE, GB, HU, PL, RU	G	Dry and warm areas	Geiter et al. (2002)
Tetramorium caldarium (Roger, 1857)	E	parasitic/ predator	Europe	1847, PT-MAD	ES-CAN, GB, PT-AZO, PT-MAD	G, J1, I2	Gardens, urban, arid sites	Wetterer et al. (2004)
Megachilidae								
Megachile rotundata (Fabricius, 1787)	A	phyto-phagous	Europe	Unknown	RU	I	Pollinator of alfalfa	Pesenko and Astafurova (2003)
Pamphiliidae								
Acantholyda erythrocephala L. 1758	E	parasitic/ predator	Europe	Unknown	GB	G3	*Pinus*	Fitton et al. (1978)
Acantholyda (*Itycorsia*) *laricis* (Giraud, 1861)	E	phyto-phagous	Europe	1986, NL	BE, NL	G3	*Larix*	Magis (1988)
Cephalcia abietis (Linnaeus, 1758)	E	phyto-phagous	Europe	1986, NL	NL	G3	*Picea*	van Achterberg and van Aartsen (1986)
Cephalcia alpina (Klug, 1808)	E	phyto-phagous	Europe	1988, BE	BE, LU	G3	*Picea*	Magis (1988)
Cephalcia erythrogaster (Hartig, 1837)	E	phyto-phagous	Europe	1986, NL	BE, NL	G3	*Picea*	Magis (1988)
Cephalcia lariciphila (Wachtl, 1898)	E	phyto-phagous	Europe	1941, NL	BE, DK, GB, LT, NL, SE, UA	G3	*Larix*	Billany and Brown (1980)
Pteromalidae								
Lariophagus distinguendus (Förster, 1841)	E	parasitic/ predator	Europe	2005, PT-AZO	PT-AZO	J	Stored products weevils, *Sitophilus*, in grain	
Siricidae								
Sirex juvencus (Linnaeus, 1758)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	Conifers	Fitton et al. (1978)

Families *Species*	Status	Regime	Native range	First Record	Invaded countries	Habitat	Host	References
Sirex noctilio Fabricius, 1773	E	phyto-phagous	Europe	Unknown	GB	G3	*Pinus, Abies, Larix*	Fitton et al. (1978)
Urocerus gigas (Linné, 1758)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	Conifers	Fitton et al. (1978)
Xeris spectrum (Linnaeus, 1758)	E	phyto-phagous	Europe	1951, GB	GB	G3	Conifers	Fitton et al. (1978)
Tenthredinidae								
Ametastegia (*Protemphytus*) *pallipes* (Spinola, 1808)	E	phyto-phagous	Europe	Unknown, GB	GB	I2	*Viola*	Fitton et al. (1978)
Anoplonyx destructor Benson, 1952	E	phyto-phagous	Europe	1953, GB	DK, EE, GB, HU, IE, SE	G3, I2	*Larix*	Leston (1988), Piekarczyk and Wright (1988), Speight (1979)
Athalia rosae (Linnaeus, 1758)	E	phyto-phagous	Europe	Unknown, GB	GB	I,J	*Brassica, Sinapis*	Fitton et al. (1978)
Hoplocampa brevis (Klug, 1816)	E	phyto-phagous	Europe	1935, GB	GB	I2, G5	*Pyrus*	Fitton et al. (1978)
Nematus (*Pteronidea*) *spiraeae* Zaddach, 1883	E	phyto-phagous	Europe	1824, GB	GB	I2	*Spiraea, Aruncus*	Fitton et al. (1978)
Pachynematus (*Epicenematus*) *montanus* (Zaddach, 1883)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	*Picea*	Fitton et al. (1978)
Pachynematus (*Larinematus*) *imperfectus* (Zaddach, 1876)	E	phyto-phagous	Europe	1915, DK	BE, DK, GB, HU, LV, NL	G3, G5	*Larix*	Fitton et al. (1978)
Pachynematus (*Pikonema*) *scutellatus* (Hartig, 1837)	E	phyto-phagous	Europe	Unknown	GB, IE	G3	*Picea*	Fitton et al. (1978)

Families *Species*	**Status**	**Regime**	**Native range**	**First Record**	**Invaded countries**	**Habitat**	**Host**	**References**
Pachyprotasis variegata (Fallen, 1808)	E	phyto-phagous	Europe	Unknown, GB	GB	I,J	*Digitalis, Plantago*	Fitton et al. (1978)
Phymatocera aterrima (Klug, 1816)	E	phyto-phagous	Europe	1846, GB	GB	I2, G1	*Polygonatum*	Fitton et al. (1978)
Pristiphora (*Lygaeonematus*) *abietina* (Christ, 1791)	E	phyto-phagous	Europe	Unknown, IE	IE	G3	*Picea*	
Pristiphora (*Lygaeonematus*) *compressa* (Hartig, 1837)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	*Picea*	Fitton et al. (1978)
Pristiphora (*Lygaeonematus*) *erichsonii* (Hartig, 1837)	E	phyto-phagous	Europe	1906, GB	DK, EE, ES, GB, IE, LV, NL, NO, SE	G3, I2, FB	*Larix*	Fitton et al. (1978)
Pristiphora (*Lygaeonematus*) *glauca* Benson, 1954	E	phyto-phagous	Europe	1954, GB	GB	G3	*Larix*	Fitton et al. (1978)
Pristiphora (*Lygaeonematus*) *saxesenii* (Hartig, 1837)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	*Picea*	Fitton et al. (1978)
Pristiphora (*Lygaeonematus*) *subarctica* (Forsslund, 1936)	E	phyto-phagous	Europe	1949, GB	GB	G3	*Picea*	Fitton et al. (1978)
Pristiphora (*Lygaeonematus*) *wesmaeli* (Tischbein, 1853)	E	phyto-phagous	Europe	1915, DK	BE, BY, DK, EE, GB, NL, SE, GB	G3, I2, FB	*Larix*	Fitton et al. (1978)
Pristiphora (*Oligonematus*) *laricis* (Hartig, 1837)	E	phyto-phagous	Europe	1915, DK	BE, DK, EE, ES, GB, HU, IE, ME, NL, RS, SE, UA	G3, FB, I2	*Larix*	Fitton et al. (1978)

Families *Species*	Status	Regime	Native range	First Record	Invaded countries	Habitat	Host	References
Pristiphora (*Pristiphora*) *angulata* Lindqvist, 1974	E	phyto-phagous	Europe	1995, FI	EE, FI	FA, I2	*Spiraea chamaedryfolia*	Lindqvist (1974)
Pristiphora (*Pristiphora*) *leucopus* (Hellén, 1948)	E	phyto-phagous	Europe	2004, GB	GB	G3, G4	*Tilia*	Fitton et al. (1978)
Pristiphora (*Pristiphora*) *thalictri* (Kriechbaumer, 1884)	E	phyto-phagous	Europe	1946, GB	GB	I2	*Thalictrum*	Fitton et al. (1978)
Pristiphora (*Sharliphora*) *amphibola* (Förster, 1854)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	*Picea*	Fitton et al. (1978)
Pristiphora (*Sharliphora*) *nigella* Förster, 1854)	E	phyto-phagous	Europe	Unknown, GB	GB	G3	*Picea*	Fitton et al. (1978)
Torymidae								
Megastigmus pictus (Förster, 1841)	E	phyto-phagous	Europe	1879, GB	IE, GB	G3, G4,X11	*Larix*	Roques and Skrzypczynska (2003)
Megastigmus suspectus Borries, 1895	E	phyto-phagous	Europe	1943, IE	IE, GB	G3, G4,X11	*Abies*	Roques and Skrzypczynska (2003)
Megastigmus wachtli Seitner, 1916	E	phyto-phagous	Asia-Temperate	1915, SI	AL, BA, BG, ES, FR-COR, FR, GR, HR, IL, IT, ME, MT, PT, RO, RS, SI	G5, I2, X15	*Cupressus*	Rasplus et al. (2000), Roques and Skrzypczynska (2003)
Trichogrammatidae								
Trichogramma brassicae Bezdenko, 1968	E	parasitic/ predator	Europe	1996, DE	AT, BG, CH, DE, ES, FR, NL, RO	I1	*Ostrinia* corn borer but highly polyphagous	Pintureau (2008)
Vespidae								
Vespula germanica (Fabricius, 1793)	E	parasitic/ predator	Europe	Unknown, IS	IS	G3, G4	Woodland	Olafsson (1979)
Vespula vulgaris (Linné, 1758)	E	parasitic/ predator	Eurasia	Unknown	FÖ, IS	H, X25	Woodland	Olafsson (1979)

Table 12.3. Number of alien Hymenoptera per European countries.

Countries	N	Countries	N
Italy mainland	144	Finland mainland	13
France mainland	111	Italy Sardinia	13
Spain mainland	90	Montenegro	11
Israel	82	Spain Balearic islands	11
Germany mainland	80	Croatia	10
Greece mainland	50	Norway mainland	10
Great Britain	45	Ireland	10
Czech Republic	41	Malta	8
Netherlands	40	Moldova	8
Denmark	36	Slovenia	8
Italy Sicily	36	Lithuania	7
Portugal mainland	35	Portugal Azores	7
Russia	33	Greece Crete	6
Belgium	32	Estonia	5
Austria	31	Luxemburg	4
Hungary	30	Greenland	3
Spain Canary islands	30	Iceland	2
Switzerland	30	Belarus	2
Poland	26	FinlandAland	2
Sweden	23	Greece South Aegean Isl	2
Cyprus	23	Latvia	1
Bulgaria	22	Bosnia	1
Ukraine	22	Feroe Islands	1
France Corsica	19	Greece North Aegean Isl	1
Romania	18	Norway Svalbard	1
Portugal Madeira	18	Andorra	0
Slovakia	18	FYRM Macedonia	0
Albania	17	Greece Ionian islands	0
Former Yougoslavia	14	Lichtenstein	0
Serbia	14		